B.C.Hydro

Preliminary Planning Report for the Stikine-Iskut Transmission System

A summary of System Planning,
Route Engineering, and Environmental Studies

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PRELIMINARY PLANNING REPORT

FOR THE

STIKINE-ISKUT TRANSMISSION SYSTEM

SE 8214

DECEMBER 1982

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1 Introduction

B.C. Hydro is investigating the hydroelectric potential of the Stikine and Iskut rivers in northwestern British Columbia and the transmission lines required to transmit this energy to the provincial electric system. Preliminary planning studies that have been carried out for the transmission portion of the proposed Stikine-Iskut development include:

i) system planning studies which determined the transmission voltage and number of lines required as well as the electrical implications of connecting into the various possible stations in the grid;

ii) route engineering studies which identified and evaluated technically feasible corridors for the required number of transmission lines between the generation sites and the possible stations;

iii) environmental studies which assessed the potential environmental impacts that could be associated with construction and operation of transmission lines along the feasible corridors.

1.1 Purpose of This Report

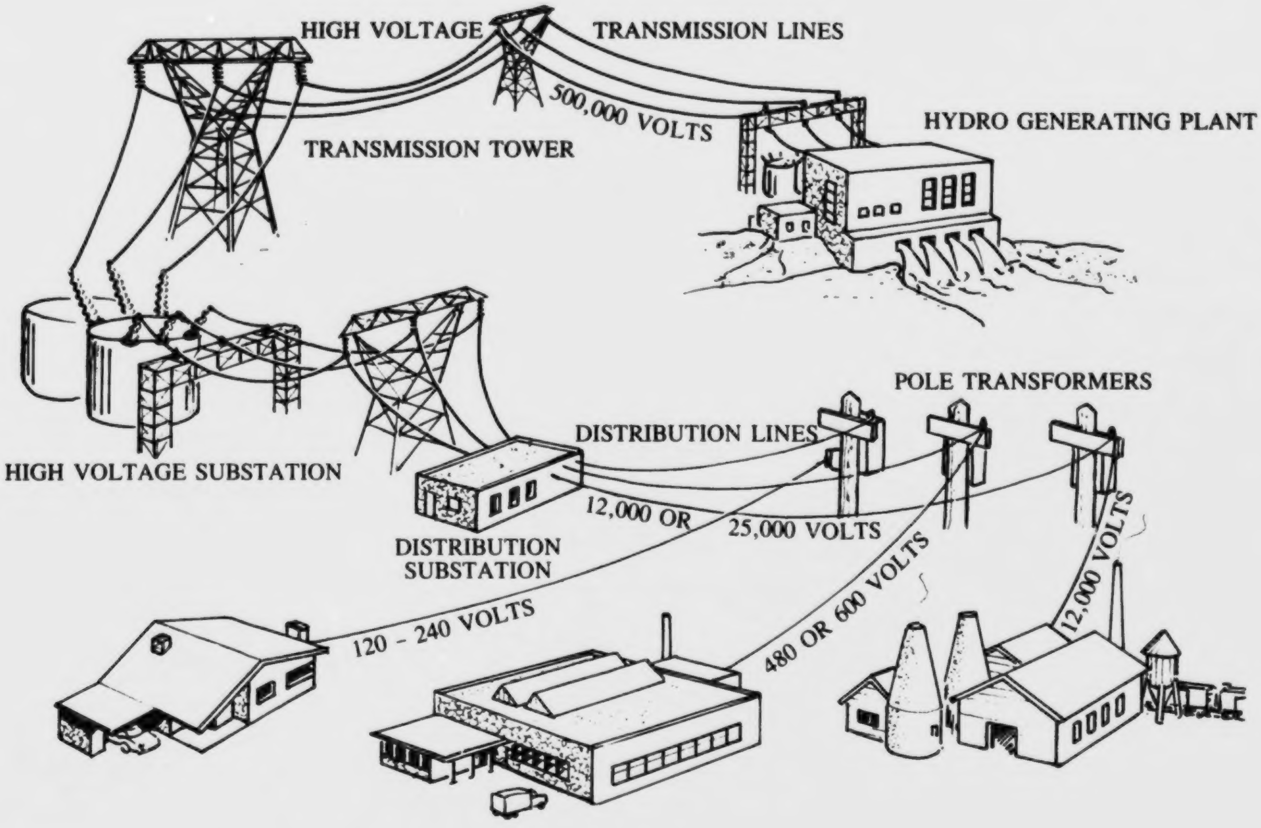
This report summarizes information from the preliminary transmission studies and is intended for wide distribution to facilitate government review and public consultation. The public consultation program is described in Section 1.3.2.

The feasible transmission corridors are identified in Section 3.5. Based on the preliminary studies, corridors are recommended for further, more detailed engineering and environmental route location studies. The rationale for these recommendations is presented in Section 6.4 and the recommended corridors are shown on Figure 7-1. Following government review of preliminary reports and public consultation, B.C. Hydro will make a final selection of corridors for detailed route location studies. The appendices to this report contain additional information recommended for preliminary planning reports in the Guide to the Energy Project Review Process issued by the Ministry of Energy, Mines and Petroleum Resources in January 1982. Included are a preliminary procurement plan (Appendix VII) and a preliminary list of licences and approvals (Appendix VIII).

1.2 B.C. Hydro's Major Transmission System

Transmission of large quantities of power over long distances requires extra-high voltage circuits for economic operation. B.C. Hydro's major transmission lines are designed at present for operation at 500,000 volts (500 kV). Voltage step-down substations are located near load centres to reduce this voltage to lower levels more suitable for transmission over shorter subtransmission and distribution distances.

The major transmission lines and their associated switching and step-down substations are collectively called the system grid. A conceptual drawing of a system grid and its relationship to other system components, such as generation and distribution, is shown in Figure 1-1. The existing and proposed B.C. Hydro 500 kV transmission system preceding the Stikine-Iskut development is shown in Figure 1-2.


HIGH VOLTAGE
TRANSMISSION LINES
500,000 VOLTS
HYDRO GENERATING PLANT
TRANSMISSION TOWER
POLE TRANSFORMERS
DISTRIBUTION LINES
HIGH VOLTAGE SUBSTATION
12,000 OR
25,000 VOLTS
DISTRIBUTION SUBSTATION
120 - 240 VOLTS
480 OR 600 VOLTS
12,000 VOLTS

RELATIONSHIP OF GENERATION, TRANSMISSION AND DISTRIBUTION

FIGURE 1-1

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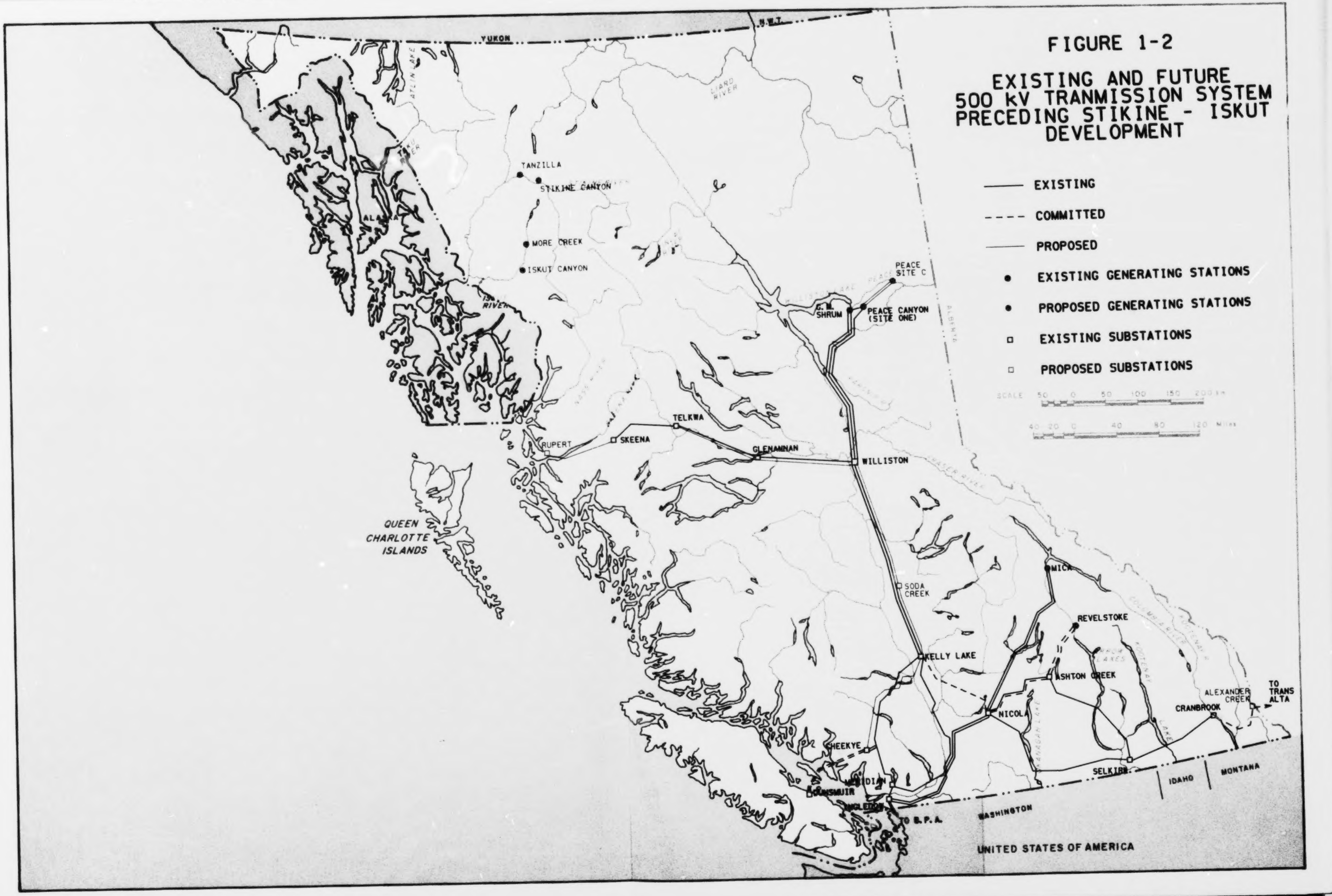


FIGURE 1-2

EXISTING AND FUTURE 500 kV TRANMISSION SYSTEM PRECEDING STIKINE - ISKUT DEVELOPMENT

EXISTING
COMMITTED
PROPOSED
EXISTING GENERATING STATIONS
PROPOSED GENERATING STATIONS
EXISTING SUBSTATIONS
PROPOSED SUBSTATIONS
SCALE 50 0 50 100 150 200 km
40 20 0 40 80 120 Miles
YUKON
N.W.T.
ATLIN LAKE
LIARD RIVER
ALASKA
TANZILLA
STIKINE CANYON
MORE CREEK
ISKUT CANYON
PEACE SITE C
G.M. SHRUM
PEACE CANYON (SITE ONE)
ALBERTA
TELKWA
SKEENA
RUPERT
GLENANNAN
WILLISTON
FRASER RIVER
QUEEN CHARLOTTE ISLANDS
SODA CREEK
MICA
REVELSTOKE
KELLY LAKE
ASHTON CREEK
NICOLA
CHEEKYE
MERIDIAN
DUNSMUIR
INGLEDOW
TO B.P.A.
SELKIRK
CRANBROOK
ALEXANDER CREEK
TO TRANS ALTA
WASHINGTON
IDAHO
MONTANA
UNITED STATES OF AMERICA

1.3 Transmission Planning for the Stikine-Iskut Development

The following subsections outline the history of transmission studies that have been carried out to date for the Stikine-Iskut development, and describe the process of public consultation and further studies that would precede a development application under the Utilities Commission Act. Figure 1-3 shows schematically the transmission planning process that B.C. Hydro follows. A schedule of planning activities for Stikine-Iskut transmission is presented in Figure 1-4.

The transmission planning for the Stikine-Iskut development is part of a much larger planning process that B.C. Hydro carries out for British Columbia's future electric system. This process is outlined in Electric System Plans 1981-1995 published by B.C. Hydro in December 1980. The rules and guidelines B.C. Hydro applies in combination with experienced engineering judgement for planning a reliable system are discussed in System Planning Criteria published by B.C. Hydro in August 1982. Copies of these reports can be obtained from the Community Relations Department of B.C. Hydro.

1.3.1 Studies' Background

Long-range electric load forecasts for the province indicate a need for major new sources of electric power by the end of this century. Generation planning studies have identified the hydroelectric potential of the Stikine and Iskut rivers in northwest B.C. and the Liard River in northern B.C. as possible sources of this power. Transmission overview studies were carried out in 1978 and 1979. They concluded that if projects in both areas were to be developed, there would be system advantages if transmission lines from each were interconnected in the vicinity of Prince George. This would minimize the number of additional transmission lines required to bring some of the power to the Lower Mainland.

Stage I environmental and engineering route selection studies for transmission from both projects started in April 1980. Those studies were planned according to the requirements of the "Guidelines for Linear Development" issued in March 1977 by the provincial Environment and Land Use Committee. A prospectus, "Northern Transmission Studies", was published in July 1980 and described the environmental and engineering studies that B.C. Hydro intended to carry out.

This preliminary planning report deals with studies of the transmission required to connect the Stikine-Iskut generation facilities to the system grid. Studies for Liard transmission and for transmission that would be required to reinforce the system south of Prince George will be reported separately when plans for those projects are more certain.

The Stikine-Iskut development (generation and transmission) is regulated under provisions of the British Columbia Utilities Commission Act. The transmission studies summarized in this report are part of the preliminary planning, preapplication phase, outlined in the Guide to the Energy Project Review Process.

1.3.2 Public Consultation

B.C. Hydro will begin a formal public consultation program with the release of this report and the backup preliminary route engineering and environmental reports. Meetings will be requested with local governments and interest groups. Meetings will also be held with the general public in communities located in the study area. These meetings are intended to focus on the transmission aspects of the Stikine-Iskut development although Hydro will be prepared to respond to questions on the development as a whole.

The public consultation program will provide interested groups and individuals with the opportunity to voice their opinions and concerns about plans to transmit power from the proposed generating sites to the provincial grid. The program will also provide B.C. Hydro with input and information which will assist in the final selection of transmission line corridors for the next, more detailed stage of engineering and environmental route location studies.

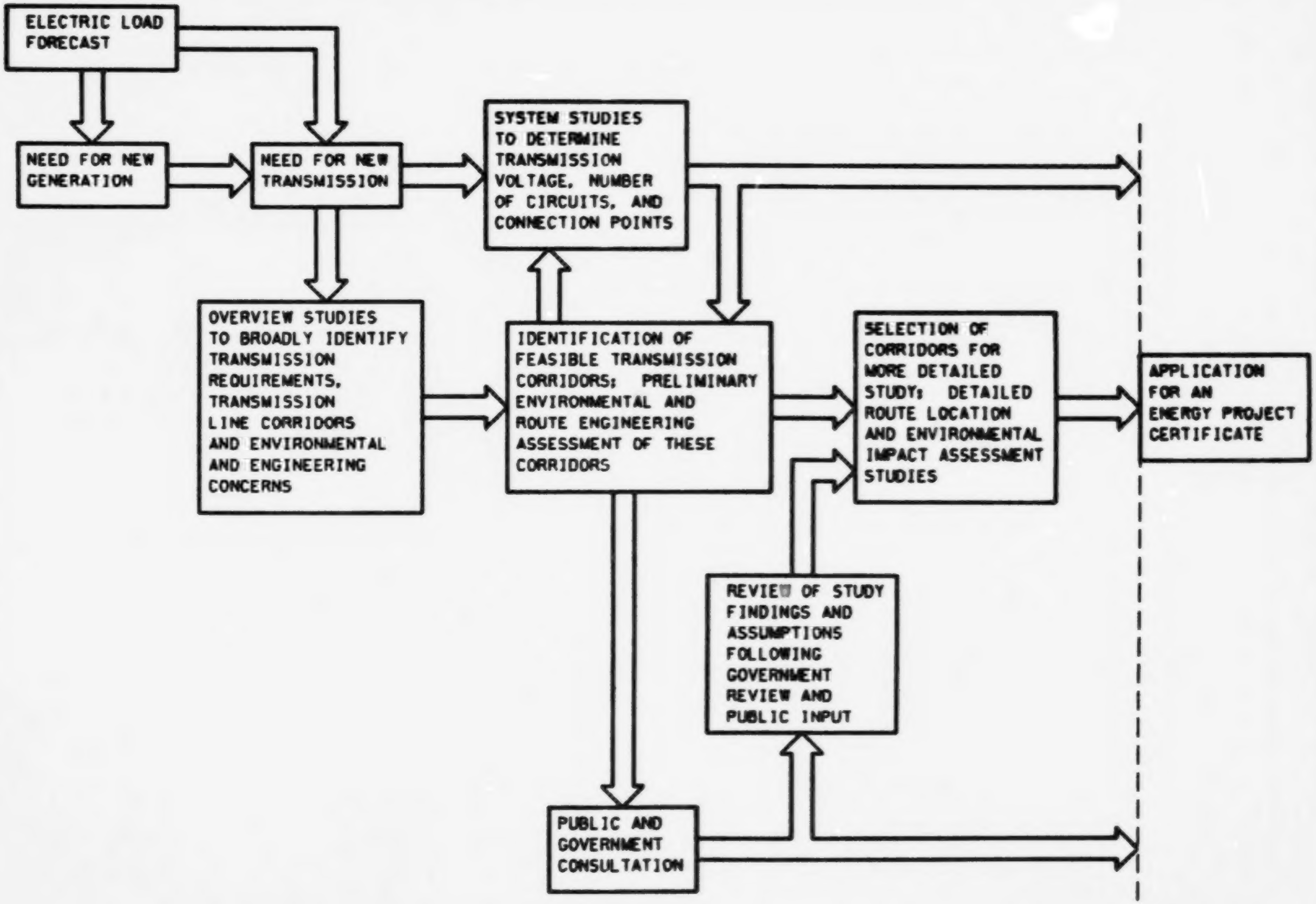
The consultation program will continue throughout the duration of the detailed studies in order to keep the public informed about the studies and project status and to provide for continuing public input. B.C. Hydro will respond to the issues raised during the program.

This preliminary planning report is being given wide distribution throughout the study area. Copies and further information about the project can be obtained from the Community Relations Department, B.C. Hydro, 970 Burrard Street, Vancouver, B.C., V6Z 1Y3 or by telephoning

663-4344. Collect, long distance calls are accepted. The preliminary environmental and route engineering reports have been sent to government agencies, interest groups, public libraries and B.C. Hydro district offices and will be available to other groups and individuals on request.

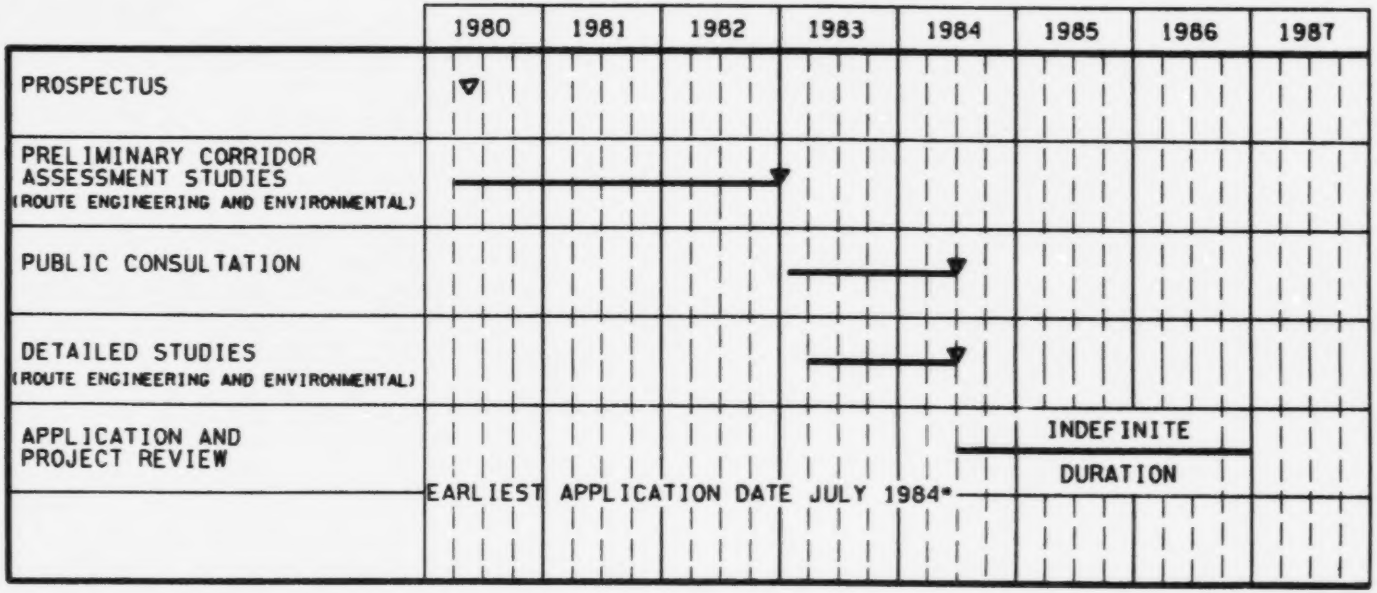
1.3.3 Detailed Studies and Application

B.C. Hydro will select transmission line corridors for detailed engineering and environmental route location studies based upon the preliminary studies and consultation with the public and government agencies. Detailed studies will focus on location of transmission line routes within the selected corridors, assessment of environmental impacts, and identification of impact mitigation opportunities. Current plans are to begin these studies in the spring of 1983. The detailed studies and public consultation will form the basis for final route decisions and mitigation recommendations to be included in an application to the Minister of Energy, Mines and Petroleum Resources for an energy project certificate for the Stikine-Iskut Development.


ELECTRIC LOAD FORECAST
NEED FOR NEW GENERATION
NEED FOR NEW TRANSMISSION
SYSTEM STUDIES TO DETERMINE TRANSMISSION VOLTAGE, NUMBER OF CIRCUITS, AND CONNECTION POINTS
OVERVIEW STUDIES TO BROADLY IDENTIFY TRANSMISSION REQUIREMENTS, TRANSMISSION LINE CORRIDORS AND ENVIRONMENTAL AND ENGINEERING CONCERNS
IDENTIFICATION OF FEASIBLE TRANSMISSION CORRIDORS; PRELIMINARY ENVIRONMENTAL AND ROUTE ENGINEERING ASSESSMENT OF THESE CORRIDORS
SELECTION OF CORRIDORS FOR MORE DETAILED STUDY; DETAILED ROUTE LOCATION AND ENVIRONMENTAL IMPACT ASSESSMENT STUDIES
APPLICATION FOR AN ENERGY PROJECT CERTIFICATE
REVIEW OF STUDY FINDINGS AND ASSUMPTIONS FOLLOWING GOVERNMENT REVIEW AND PUBLIC INPUT
PUBLIC AND GOVERNMENT CONSULTATION

TRANSMISSION PLANNING PROCESS FIGURE 1-3

STIKINE/ISKUT TRANSMISSION STUDIES PLANNING SCHEDULE



*SUBJECT TO CHANGES IN SYSTEM PLAN DEVELOPMENT

FIGURE 1-4

[12, 1]STISCH. DGN

2 The Study Area

Most of northwestern B.C. is within the study area. In particular, the study area lies east of the Coast Mountains and includes portions of the Skeena and Hazelton mountains, the Stikine and Nechako plateaus, and the Nass and Fraser basins. See Figure 2-1.

It is a complex region with extreme topographic variations, ranging from relatively flat plains and plateaus to rugged mountains, steep valleys and river canyons. The southeastern portion consists of rugged forested plateau with many large lakes.

The climate is harsh with brief summers and cold winters. However, moderating marine air masses move up the Skeena Valley, causing the climate near Terrace to be warmer and wetter year-round than farther east in the Interior.

2.1 Natural Resources

Forests dominate the rugged landscape and, in turn, provide the basis for the principal economic activities in the study area. In addition, the forests and lakes there provide habitat for important fish and wildlife populations.

The study area supports significant wildlife populations of mountain goats, stone sheep, grizzly bear and caribou. Major factors restricting wildlife population levels include terrain, snow accumulation, fluctuations in food supply, and limited winter range. Areas within the snow shadows of the Stikine, Klappan and Bulkley valleys and in the Fraser basin, support substantial moose and deer populations.

Fish populations in the study area are among the most important in British Columbia. Major fish bearing systems include the Stikine, Klappan, Bell-Irving, Nass, Skeena, Kispiox, Babine, Bulkley and Stuart rivers. Major lakes include Kinaskan, Bowser, Meziadin, Takla, Trembleur, Stuart, Pinchi, Tezzeron and Babine. These rivers and lakes support substantial populations of Pacific salmon as well as steelhead trout, rainbow trout, Dolly Varden char and mountain whitefish or an assemblage of sub-Arctic freshwater species. These populations provide the basis for significant sport and native Indian food fisheries. The Kispiox, Babine, Morice and Bulkley rivers are internationally renowned for steelhead fishing.

Deposits of gold, silver, molybdenum, copper, asbestos, coal and other minerals support several operating mines and provide the potential for further mining activity.

2.2 Human Settlement

Human settlement in the study area is concentrated in the south mainly along the Highway 16 corridor from Prince George to Terrace. Major centres include Prince George, Vanderhoof, Fort St. James, Houston, Smithers, Hazelton and Terrace (see Table 2-1). North of Hazelton, settlements are isolated and often relatively inaccessible. Recent population growth in northwestern B.C. has occurred mainly in smaller communities, in unincorporated areas, and on Indian reserves rather than in the major centres. A significant amount of dispersed rural settlement exists, particularly in the Bulkley-Nechako region. At the same time, much of the study area is, and will likely continue to be, uninhabited.

An estimated 20 to 25 per cent of the population of northwestern B.C. are status and non-status Indians. Some of the transmission corridors studied pass through rural areas inhabited almost solely by Indians.

Table 2-1

Population in the Study Area*

	1971	1976	1981
Bulkley-Nechako Regional District	27,145	32,617	38,309
Kitimat-Stikine Regional District	37,326	38,718	42,400
Fort St. James	1,484	2,110	2,284
Hazelton	351	371	393
Houston	2,232	2,673	3,921
Prince George	49,365	59,929	67,559
Smithers	3,864	3,783	4,570
Terrace	9,991	10,251	10,914
Vanderhoof	1,653	1,990	2,323

*Statistics Canada

2.3 Transportation

Although much of the study area is relatively inaccessible, air transport, rail and highways serve most of its southern and western portions. Highway 16 extends west from Prince George through Smithers, Hazelton and Terrace to Prince Rupert. The Stewart-Cassiar Highway, Highway 37, extends from Hazelton through Cranberry Junction, north past Meziadin Lake to Iskut, Dease Lake and to Watson Lake. Many secondary roads and logging roads link the southern portion of the study area between Prince George and Terrace. Major airlines offer daily service from Vancouver to Prince George, Smithers and Terrace. Minor carriers and charter companies connect these centres with most of the smaller settlements. The Canadian National Railway extends west from Prince George in a common corridor with Highway 16 to Prince Rupert.

The B.C. Railway provides rail service from Prince George north and west along Takla Lake as far as the Driftwood River. However, beyond this point, the Dease Lake extension is incomplete. No tracks were laid and many bridges and culverts are missing.

2.4 Economic Activities

The forest industry is the dominant economic activity in the region. Most logging activity is accessible to the Highway 16 - C.N. Railway corridor and provides a large portion of the wood chip supply for mills in the Prince Rupert and Prince George areas. Sawmill operations are concentrated in the major communities along this corridor. Forests in the northern part of the study area are among the most extensive undeveloped softwood areas in North America.

Mineral deposits with development potential exist in many parts of the region. Developed mines include Cassiar Asbestos, Granduc Copper, Amax Molybdenum, Equity Silver, Bell Copper and Granisle Copper.

Agriculture held a dominant position in the early development of northwestern B.C., but since has become less important to the regional economy than mining, forestry and tourism. Grain and forage seeds were the first crops produced for sale outside the region. Today, beef calves and yearlings destined for Alberta feed lots are the major agricultural export commodity with annual sales in the order of ten million dollars. The area supplies most of its own milk, poultry and eggs, and a significant portion of its cold hardy vegetables.

Land with high agricultural capability is limited and therefore is critical in those areas in which it does occur. Most agricultural land in the study area occurs on the narrow valley bottoms of the Bulkley and Nechako rivers. The Skeena Valley, from Terrace to Hazelton, and the southern portion of the Kispiox Valley are important also. As the regional population increases, agricultural production will likely expand.

Guide and outfitting activities, sports hunting and fishing, and hunting and fishing for food contribute significantly to economic well-being in the region.

Trapping is important to those involved, although it does not produce large incomes for the area in most years.

Fish that originate in the region's waterways are very important economically, but most commercial fishing takes place downstream outside the study area.

Tourism and recreation are increasingly important economic activities. They are closely associated with scenic landscapes and, in particular, with wilderness, or the undeveloped character of these landscapes. To many outdoor enthusiasts, northwestern B.C. is one of the last major wilderness areas in the world. Many persons seeking true wilderness experiences are drawn to this area from all over the world.

The principal recreational activities are hunting, fishing and sightseeing. Exceptional opportunities exist for hiking, mountaineering, wilderness camping, canoeing, horseback riding, skiing, snowmobiling, nature study and photography. Recreational use patterns are largely a product of accessibility. Generally, use declines with distance from population centres although the entire length of Highway 37 is an important recreational and commercial corridor.

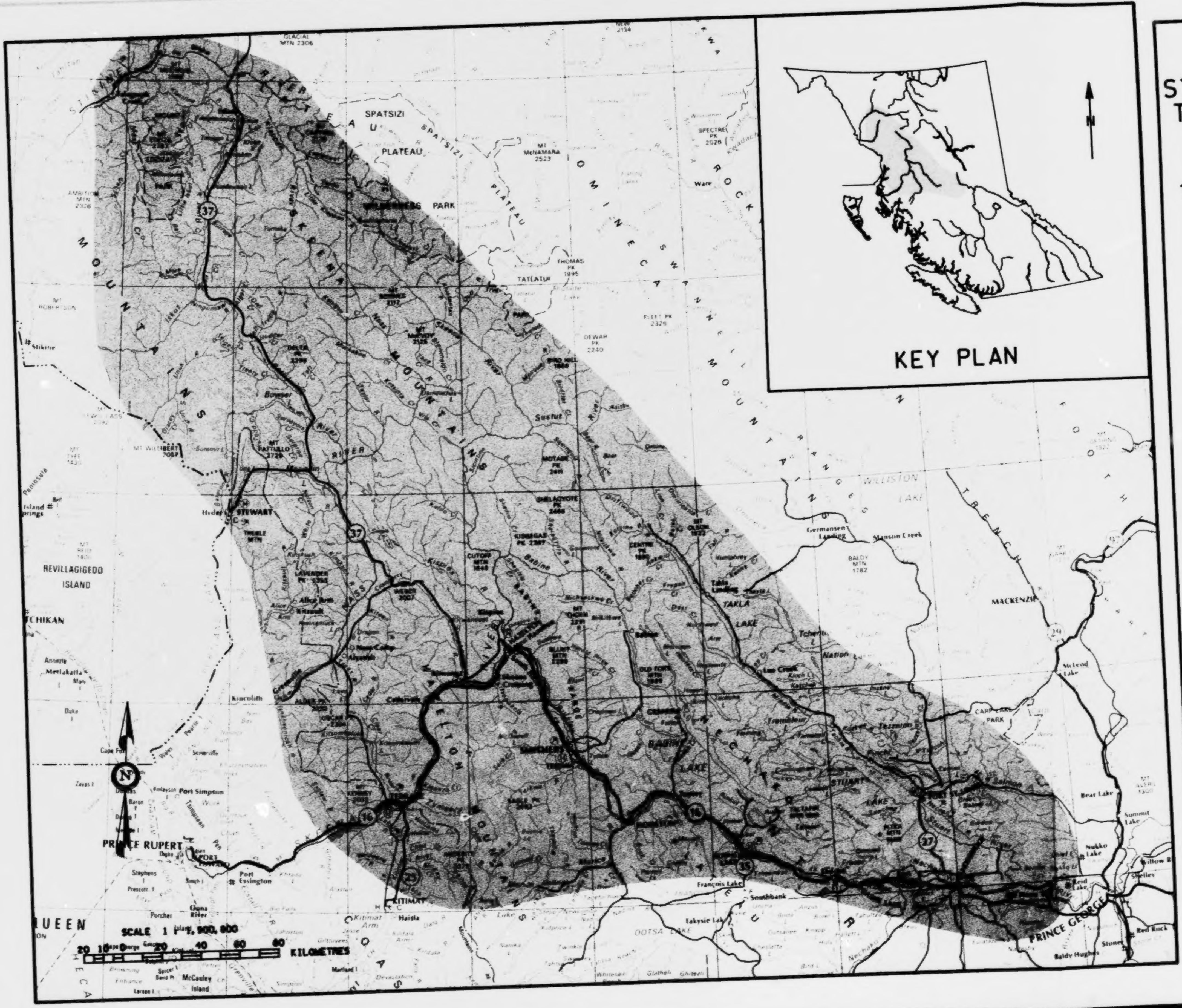

KEY PLAN
N
SPATSIZI
PLATEAU
SPATSIZI PLATEAU
WILDERNESS PARK
SKEENA MOUNTAINS
OMINECA MOUNTAINS
SWANNELL RANGES
ROCKY MOUNTAIN TRENCH
FOOTHILLS
GLACIAL MTN 2306
MT McNAMARA 2523
SPECTRE PK 2028
Ware
AMBITION MTN 2326
THOMAS PK 1995
TATLATUI
MT ROBERTSON
Stikine
FLEET PK 2326
DEWAR PK 2240
BIRD HILL 1866
Sustut
DELTA PK 2299
MT PATTULLO 2728
MT WILLIBERT 2087
STEWART
Hyder
REVILLAGIGEDO ISLAND
KETCHIKAN
Annette
Metlakatla
Kincolith
Alice Arm
Kitsault
WILLISTON LAKE
Germansen Landing
Manson Creek
BALDY MTN 1782
MACKENZIE
McLeod Lake
TAKLA LAKE
Takla Landing
Tchentlo L
Nation
Trembleur
Tezzeron
CARP LAKE PARK
STUART LAKE
BABINE LAKE
Babine
Bear Lake
Summit Lake
Nukko Lake
Reid Lake
PRINCE GEORGE
Shelley
Willow R
Red Rock
Stoner
Baldy Hughes
François Lake
Southbank
Takysie Lake
OOTSA LAKE
Nechako
Kitimat
KITIMAT
Haisla
Port Simpson
PRINCE RUPERT
PORT EDWARD
Port Essington
Porcher
QUEEN
HAZELTON
37
16
16
27
25
35
97
SCALE 1 : 1,900,000
20 10 0 20 40 60 80
KILOMETRES

FIGURE 2-1

STIKINE/ISKUT TRANSMISSION STUDIES

THE STUDY AREA

3 The Stikine-Iskut Development

3.1 Purpose of the Development

The forecast growth in demand for electricity in British Columbia indicates a requirement for a new major source of electric power in the mid-to-late 1990's. Development of the hydroelectric potential of the Stikine and Iskut rivers is being evaluated by B.C. Hydro planners as a means of meeting this anticipated demand.

There are four proposed hydroelectric generation sites in the Stikine-Iskut basin. These are Iskut Canyon on the Iskut River, a site on More Creek just upstream of its confluence with the Iskut River, and Stikine Canyon and Tanzilla on the Stikine River. In addition, diversion of the headwaters of Forrest-Kerr Creek into the headwaters of More Creek would increase the hydroelectric potential at the More Creek site. These developments could provide almost 2800 million watts (MW) of generating capacity; 935 MW from Iskut Canyon and More Creek and 1830 MW from the two sites on the Stikine. Appendix I provides more information on the generation part of the development. The Stikine-Iskut Development Status Report published by B.C. Hydro in October 1982 describes the status of generation studies and sets out the proposed program of further studies that would precede an energy project certificate application.

The transmission part of the Stikine-Iskut development is being planned so power from the proposed generating stations can be transmitted to the system grid.

Figure 1-2 shows the location of the proposed generating stations in relation to B.C. Hydro's existing and future 500 kV transmission system.

3.2 Stikine-Iskut Transmission System Studies

Electrical system studies for the Stikine-Iskut transmission project have been undertaken by the System Planning Department of B.C. Hydro. In these studies alternative transmission voltages, numbers of transmission circuits and the electrical implications of connecting at various points on the system grid continue to be examined.

Connection points for transmission lines from the Stikine-Iskut have been considered at the existing Skeena Substation near Terrace, the Telkwa Substation near Smithers and at a possible new substation that could be located west of Prince George in the vicinity of Cluculz Lake.

Ultimately, additional support will be required within the existing system to transmit some of the Stikine-Iskut energy to load centres in the south of the province. The System Planning Department is examining the general need for system reinforcement south of the Terrace, Smithers and Prince George areas. These studies will be reported when definite plans for additions to the system grid have been developed.

The configuration of a transmission system is determined primarily by the power output of associated generating stations and the distance power is to be transmitted. The potential hydroelectric generating capacity being considered for the Stikine-Iskut development is in the range of approximately 1800 - 3400 MW. The most recent studies point to approximately 2800 MW of installed capacity as the most economic development.

The approximate distance to integrate the Stikine and Iskut generating stations with the existing transmission system is 500 km to a Skeena or Telkwa destination and 700 km to a Cluculz destination.

Preliminary study results indicate that considering the amount of power to be transmitted, the distances involved and the projected costs, three-circuit, 500 kV three-phase alternating current transmission would be the most economical and technically sound plan to transmit electrical power from Stikine-Iskut generation sites to the system grid. Unless otherwise specified each circuit would be on a separate transmission line, hence the terms circuit and line are interchangeable. Other system options that were considered include high voltage direct current transmission and greater than 500 kV alternating current transmission.

3.3 Construction Duration and In-Service Sequence

The duration of construction activities and in-service sequence for the Stikine-Iskut development transmission lines and generating stations is depicted in Figure 3-1. These are estimates assuming approximately 1500 km of total transmission line construction and a particular generating station in-service sequence. Actual in-service dates depend on electric system plan development, based on regularly updated load forecasts, and the duration and outcome of the project review and licensing period.

3.4 Physical Facilities and Rights-of-Way

All transmission for the Stikine-Iskut project is planned as 500 kV except for the single circuit 230 kV line that would bring power out of the More Creek development. Typical transmission tower configurations and right-of-way requirements for 230 kV and 500 kV transmission lines are shown in Figure 3-2(A). Figure 3-2(B) shows preliminary tower configurations and right-of-way requirements for an alternative design that B.C. Hydro engineers are studying which uses an inverted delta phase configuration. The average conductor span length between support structures for 230 kV is about 275 m and for 500 kV about 400 m.

B.C. Hydro's standards for right-of-way vegetation management are described in Appendix III.

The transmission portion of the development will involve construction of transmission collector stations, capacitor stations, expansion of existing substations and possibly a new substation and an intermediate switching station. Appendix IV describes the general function of these stations and their space requirements. Their locations will be chosen in conjunction with the location of transmission line routes based on economic, technical, environmental and social considerations.

3.5 Identification of Feasible Corridors

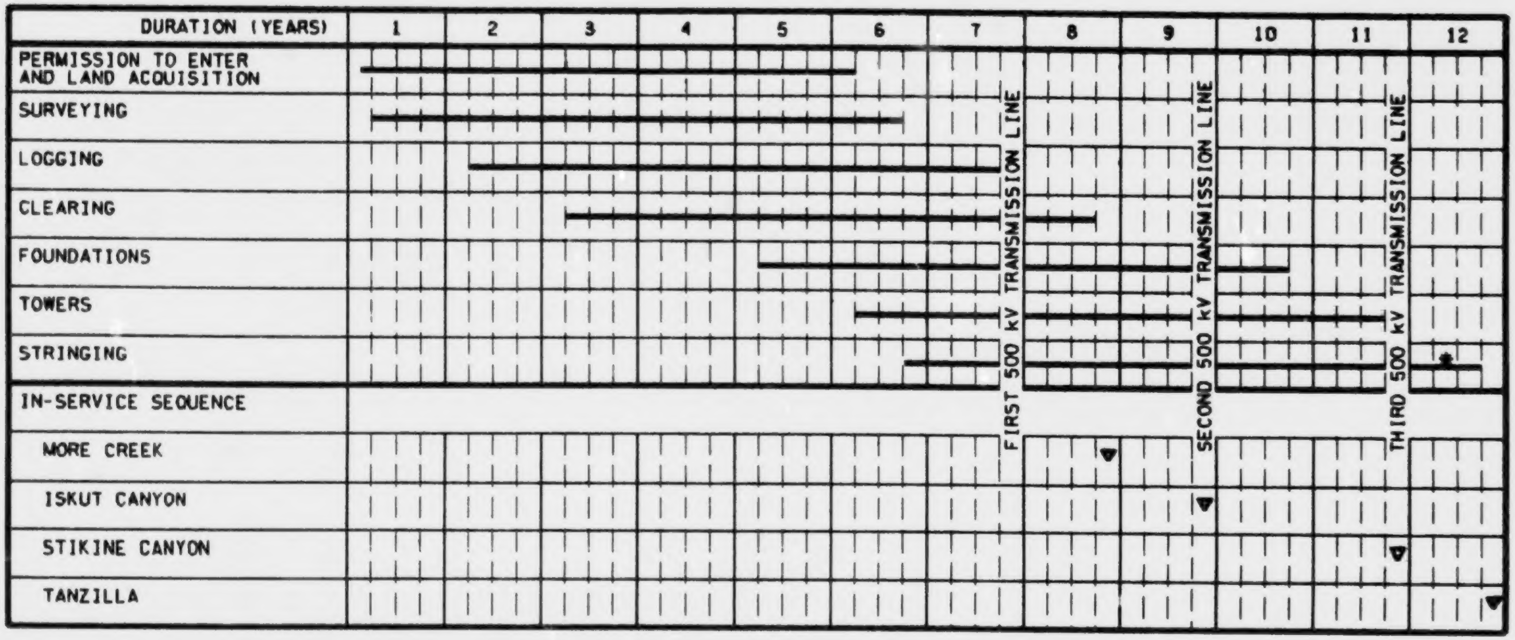
Prior to undertaking extensive engineering and environmental investigations for Stikine-Iskut transmission, it was necessary to determine corridors along which it would be technically feasible to construct secure transmission structures. The rugged terrain and the harshness of the climate limit significantly the potential feasible corridors in the study area. Preliminary investigations of corridors were based on review of topographic maps and aerial photos followed by air and ground reconnaissance and further map and photo study. The Transmission Projects Division of B.C. Hydro is continuing these studies in order to provide more complete information on the feasibility of the various corridors and the implications of constructing major transmission lines along them.

Some corridors were identified early in the studies as being technically unsuited for transmission. These include areas of high elevation where the lines would be exposed to heavy ice and wind loadings; areas with precipitous or unstable terrain; and areas where slides and avalanches could be expected.

Factors other than technical concerns were also taken into account in determining the feasibility of corridors. Corridors through provincial parks and ecological reserves were not considered to be desirable because of their special social and environmental values. Corridors through Indian reserves were also avoided where possible.

The feasible corridors identified by these preliminary engineering studies are shown on Figure 3-3.

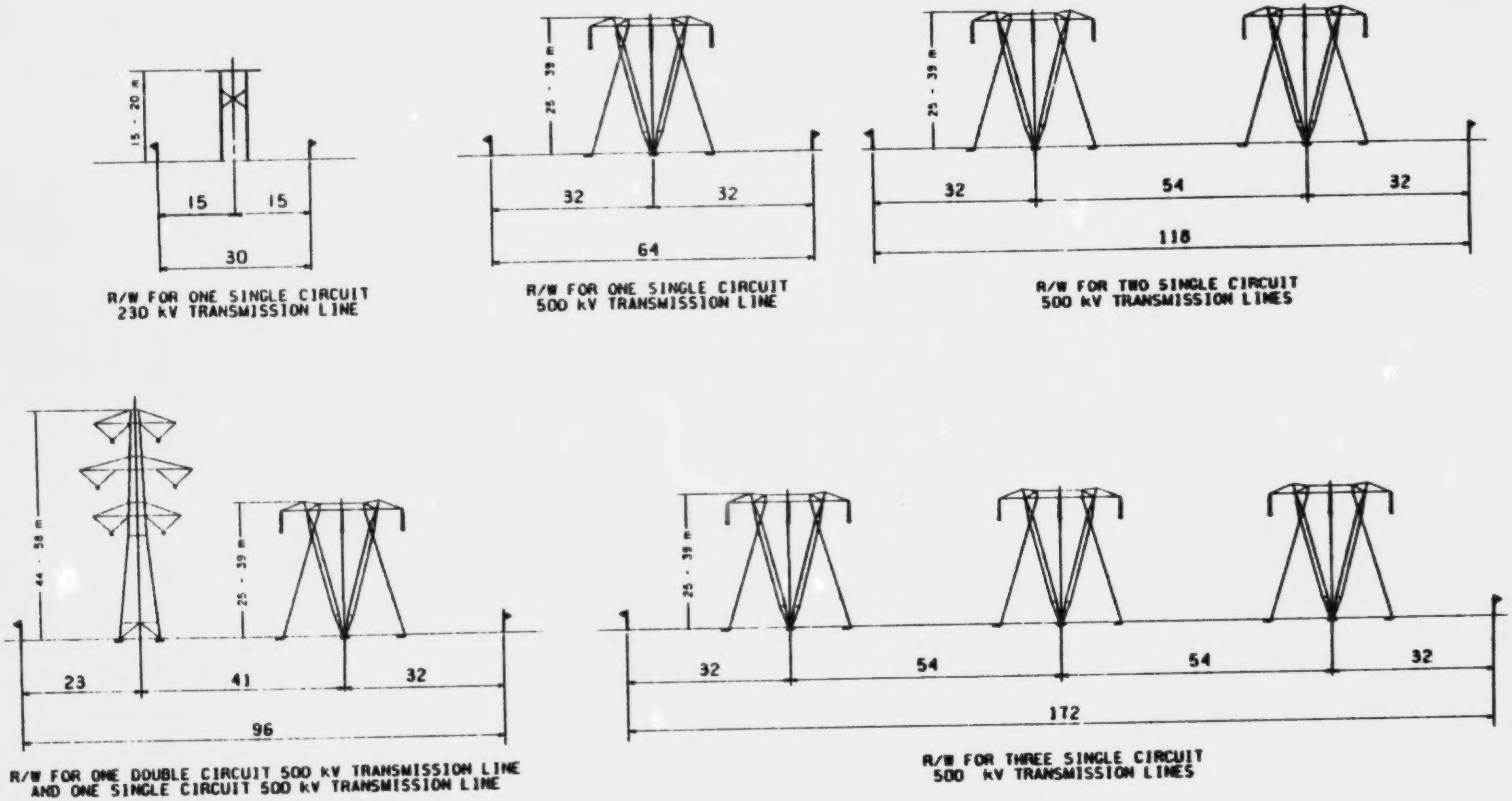
STIKINE-ISKUT DEVELOPMENT
TRANSMISSION CONSTRUCTION PERIOD AND IN-SERVICE SEQUENCE



* CONDUCTOR STRINGING BETWEEN TANZILLA AND STIKINE CANYON

FIGURE 3-1

[12, 1]STISCH.DGN


15 - 20 m
15
15
30
25 - 39 m
32
32
64
25 - 39 m
32
54
32
118
44 - 58 m
25 - 39 m
23
41
32
96
25 - 39 m
32
54
54
32
172

R/W FOR ONE SINGLE CIRCUIT 230 kV TRANSMISSION LINE

R/W FOR ONE SINGLE CIRCUIT 500 kV TRANSMISSION LINE

R/W FOR TWO SINGLE CIRCUIT 500 kV TRANSMISSION LINES

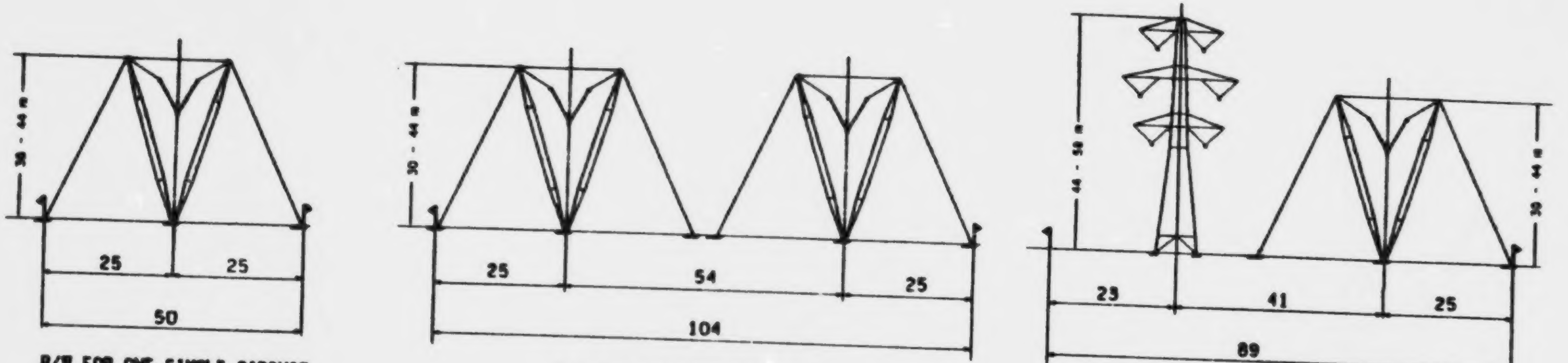
R/W FOR ONE DOUBLE CIRCUIT 500 kV TRANSMISSION LINE AND ONE SINGLE CIRCUIT 500 kV TRANSMISSION LINE

R/W FOR THREE SINGLE CIRCUIT 500 kV TRANSMISSION LINES

NOTES

1. RIGHT-OF-WAY (R/W) edge distance is based on CSA Standard C22.3 No.1 - M1979 edition.
2. Dimensions are in metres.
3. Dimensions are based on Preliminary Structure Drawings.

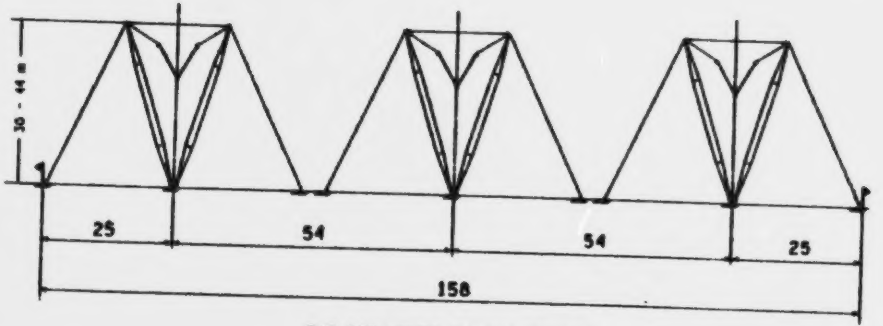
FIGURE 3-2 (A)
STIKINE-ISKUT TYPICAL TRANSMISSION TOWER CONFIGURATIONS AND RIGHT-OF-WAY REQUIREMENTS FOR 230 kV AND 500 kV CIRCUITS


30 - 44 m
25
25
50
30 - 44 m
25
54
25
104
44 - 58 m
23
41
25
89
30 - 44 m

R/W FOR ONE SINGLE CIRCUIT
500 kV TRANSMISSION LINE

R/W FOR TWO SINGLE CIRCUIT
500 kV TRANSMISSION LINES

R/W FOR ONE DOUBLE CIRCUIT 500 kV TRANSMISSION LINE
AND ONE SINGLE CIRCUIT 500 kV TRANSMISSION LINE


30 - 44 m
25
54
54
25
158

R/W FOR THREE SINGLE CIRCUIT
500 kV TRANSMISSION LINES

NOTES

1. RIGHT-OF-WAY (R/W) edge distance is based on CSA Standard C22.3 No.1 - M1979 edition.
2. Dimensions are in metres.
3. Dimensions are based on Preliminary Structure Drawings.

FIGURE 3-2 (B)
STIKINE-ISKUT ALTERNATE TRANSMISSION TOWER CONFIGURATIONS FOR THE INVERTED DELTA AND RIGHT-OF-WAY REQUIREMENTS FOR 500 kV CIRCUITS

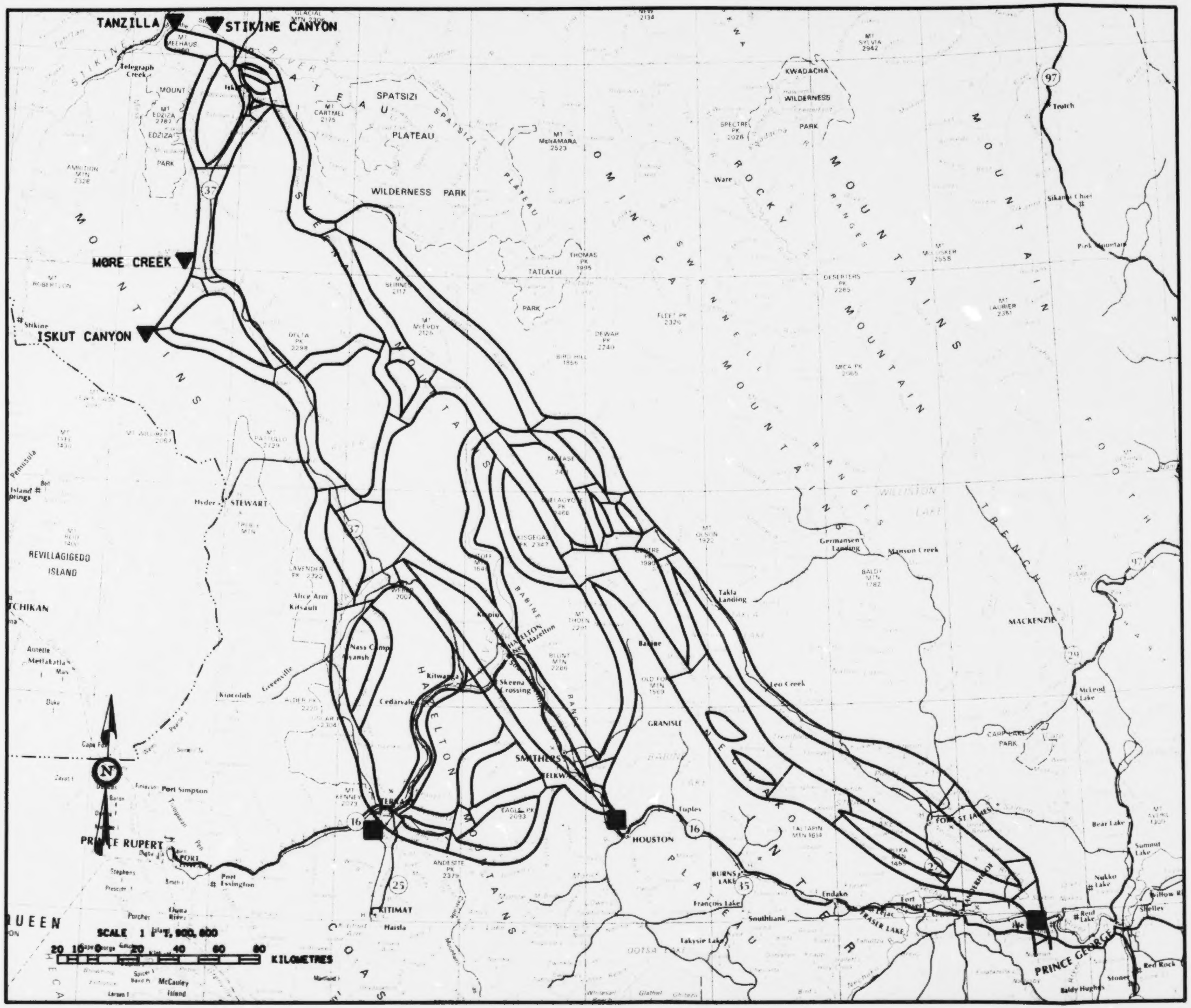

TANZILLA
STIKINE CANYON
MØRE CREEK
ISKUT CANYON
SPATSIZI
PLATEAU
WILDERNESS PARK
TATLATUI
PARK
KWADACHA
WILDERNESS
PARK
MOUNT EDZIZA
PARK
OMINECA MOUNTAINS
SWANNELL RANGES
ROCKY MOUNTAIN TRENCH
MOUNTAINS
STEWART
Hyder
REVILLAGIGEDO
ISLAND
KETCHIKAN
Alice Arm
Kitsault
Nass Camp
Aiyansh
Kitwanga
Cedarvale
HAZELTON
New Hazelton
Skeena Crossing
SMITHERS
TELKWA
HOUSTON
Topley
BURNS LAKE
Endako
Fraser Lake
Fort St James
Vanderhoof
PRINCE GEORGE
PRINCE RUPERT
Port Simpson
Port Essington
KITIMAT
Haisla
Takla Landing
Germansen Landing
Manson Creek
Babine
GRANISLE
Leo Creek
MACKENZIE
McLeod Lake
Bear Lake
Summit Lake
Telegraph Creek
Iskut
Ware
Finlay
Truitch
Sikanni Chief
Pink Mountain
CARP LAKE PARK
HAZELTON MOUNTAINS
BABINE RANGE
NECHAKO PLATEAU
COAST MOUNTAINS
Greenville
Kincolith
Stikine
16
25
27
35
37
97
N
SCALE 1 : 1,900,000
20 10 0 20 40 60 80 KILOMETRES

FIGURE 3-3

STIKINE/ISKUT TRANSMISSION STUDIES

FEASIBLE CORRIDORS

■ SUBSTATION

▼ GENERATING STATION

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.

4 Transmission Objectives and System Options

4.1 Transmission Objectives

The objectives for the Stikine-Iskut transmission are as follows:

a) To transmit power from the proposed Stikine-Iskut generation sites south to the system grid to supply future and expanding existing loads throughout the province. (The closest and most obvious points for delivery to the existing grid are Skeena Substation near Terrace and Telkwa Substation near Smithers.)

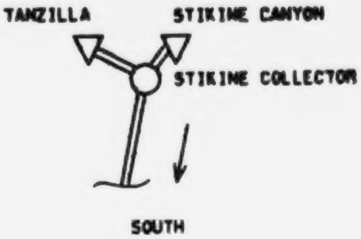
b) To provide an adequate number of transmission lines to carry all the generated power to the grid and to allow for inevitable transmission line outages.

c) To utilize as much as possible existing transmission lines and stations and those planned to be in service before the Stikine-Iskut development to carry Stikine-Iskut power to the load centres.

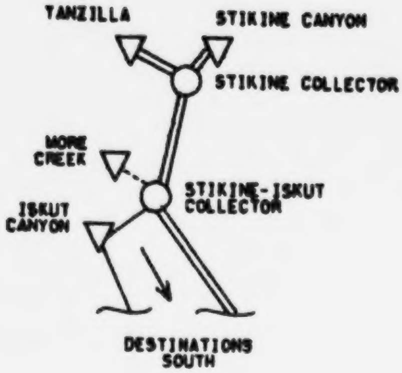
d) To improve the security of supply to existing loads in the Smithers, Terrace and Prince Rupert areas and also contribute to the serving of local loads in the more immediate project area.

Based on these objectives, the electrical requirements for Stikine-Iskut transmission are two 500 kV single-circuit transmission lines from the Tanzilla generating station, two from Stikine Canyon, two from Iskut Canyon and one 230 kV single-circuit transmission line from the More Creek development.

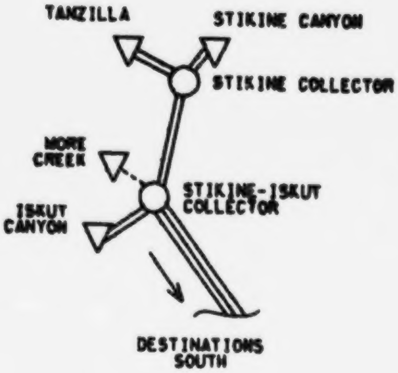
It is advantageous that the transmission lines from Tanzilla and Stikine Canyon be interconnected or collected at a collector station near the Stikine Canyon site to minimize the number of transmission lines required south from there. Only two 500 kV single-circuit transmission lines would be required south of a Stikine collector station. This can be shown as follows:



Since plans include development of Iskut River and More Creek to the south, it is advantageous to interconnect the transmission lines from the Stikine River developments with those from Iskut Canyon and More Creek at a "Stikine-Iskut collector". Only three 500 kV transmission circuits would then be required to carry Stikine-Iskut power to destinations further south. This can be shown as follows:


TANZILLA
STIKINE CANYON
STIKINE COLLECTOR
MORE CREEK
STIKINE-ISKUT COLLECTOR
ISKUT CANYON
DESTINATIONS SOUTH

or


TANZILLA
STIKINE CANYON
STIKINE COLLECTOR
MORE CREEK
STIKINE-ISKUT COLLECTOR
ISKUT CANYON
DESTINATIONS SOUTH

Preliminary map and field studies confirmed that a suitable location for a Stikine-Iskut collector could be in the Bob Quinn Lake area near the confluence of More Creek and the Iskut River; the Bob Quinn collector.

At the same time that system studies were going on to determine electrical solutions for transmission of Stikine-Iskut power, preliminary environmental and route engineering studies were under way to evaluate feasible corridors within which transmission lines could be located. The engineering studies confirmed the feasibility of routing transmission lines to meet the electrical requirements and identified particular areas within the corridors that presented security, maintenance and cost concerns. The environmental studies in turn identified areas that were environmentally sensitive to transmission line location. For example, the Highway 37 corridor along the Ningunsaw River south of Bob Quinn Lake was identified as environmentally sensitive and an alternative to routing transmission lines there was sought. This led to consideration of an alternate Stikine-Iskut collector station location near the confluence of Muckaboo Creek and the Nass River; the Muckaboo collector.

If the Muckaboo location were to be used for the Stikine-Iskut collector, the 230 kV transmission line from More Creek would have to terminate at the Iskut Canyon generation site because of the distance of the More Creek generation site from the Muckaboo location. Other locations for the Stikine-Iskut collector are possible, and have been considered in studies summarized later in this report.

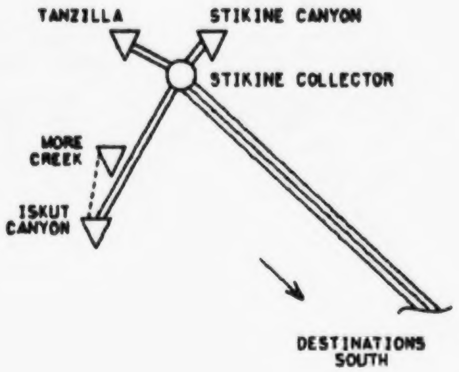
In addition to studying transmission requirements for the Stikine-Iskut development, B.C. Hydro examined transmission systems that included both the Stikine-Iskut and Liard developments. Interconnection of transmission from the two developments appeared desirable to minimize the transmission system reinforcement required to supply southern load centres. The Cluculz Lake area west of Prince George was identified as a suitable location for a station to collect Stikine-Iskut and Liard power.

During the search for electrical solutions for transmitting Stikine-Iskut power, generation output optimization studies were continuing. There was indication that significantly more than 2800 MW might be available from the four Stikine-Iskut hydroelectric generation sites. With a higher generation output, it was necessary to consider the merits of transmission voltages higher than 500 kV, particularly for the long distance route to Cluculz. This complemented similar studies of higher transmission voltages being carried out concurrently for possible Liard River development.

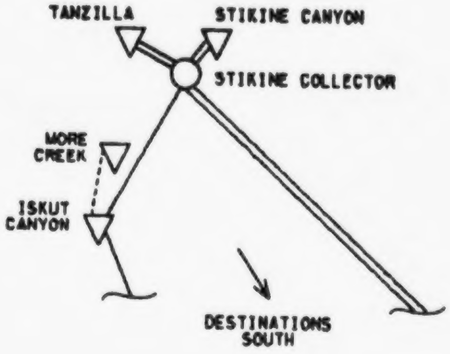
The B.C. Railway corridor was an obvious alternative to a higher voltage direct-to-Cluculz connection, and was added to the corridors being studied.

Subsequent optimization studies showed that a generation output from the Stikine-Iskut project greater than 2800 MW was not a good technical and economic choice. Therefore, 500 kV remained the preferred voltage for Stikine-Iskut transmission. However, because the Cluculz corridors had been examined and were also feasible for 500 kV transmission, they continued to be included in the preliminary studies.

The location and length of the Cluculz corridors made it electrically advantageous to interconnect Iskut and More Creek power with Stikine power at the Stikine collector thereby eliminating the need for two collector stations. This can be shown as follows:


TANZILLA
STIKINE CANYON
STIKINE COLLECTOR
MORE CREEK
ISKUT CANYON
DESTINATIONS SOUTH

or


TANZILLA
STIKINE CANYON
STIKINE COLLECTOR
MORE CREEK
ISKUT CANYON
DESTINATIONS SOUTH

4.2 System Options

Based on the transmission objectives and examination of electrical solutions for transmitting Stikine-Iskut power, four basic system options have evolved. These options can be described and shown by identifying them with the terminal destinations of the transmission lines carrying all the power from both the Stikine and Iskut generation sites:

I. One 500 kV single-circuit transmission line to Skeena Substation, two to Telkwa Substation.
II. Three 500 kV single-circuit transmission lines to Telkwa Substation.
III. One 500 kV single-circuit transmission line to Skeena Substation, two to Cluculz Substation.
IV. Three 500 kV single-circuit transmission lines to Cluculz Substation.

Options II and IV include an additional single-circuit 500 kV transmission line between Telkwa Substation and Skeena Substation that may ultimately be required to provide backup to the Terrace-Prince Rupert area. Options I and III provide this backup with the single-circuit 500 kV transmission line to Skeena Substation. Diagrams of these four system options are shown in Figure 4-1. The preliminary environmental and route engineering corridor assessment studies have addressed these system options in their determinations of corridor preferences.

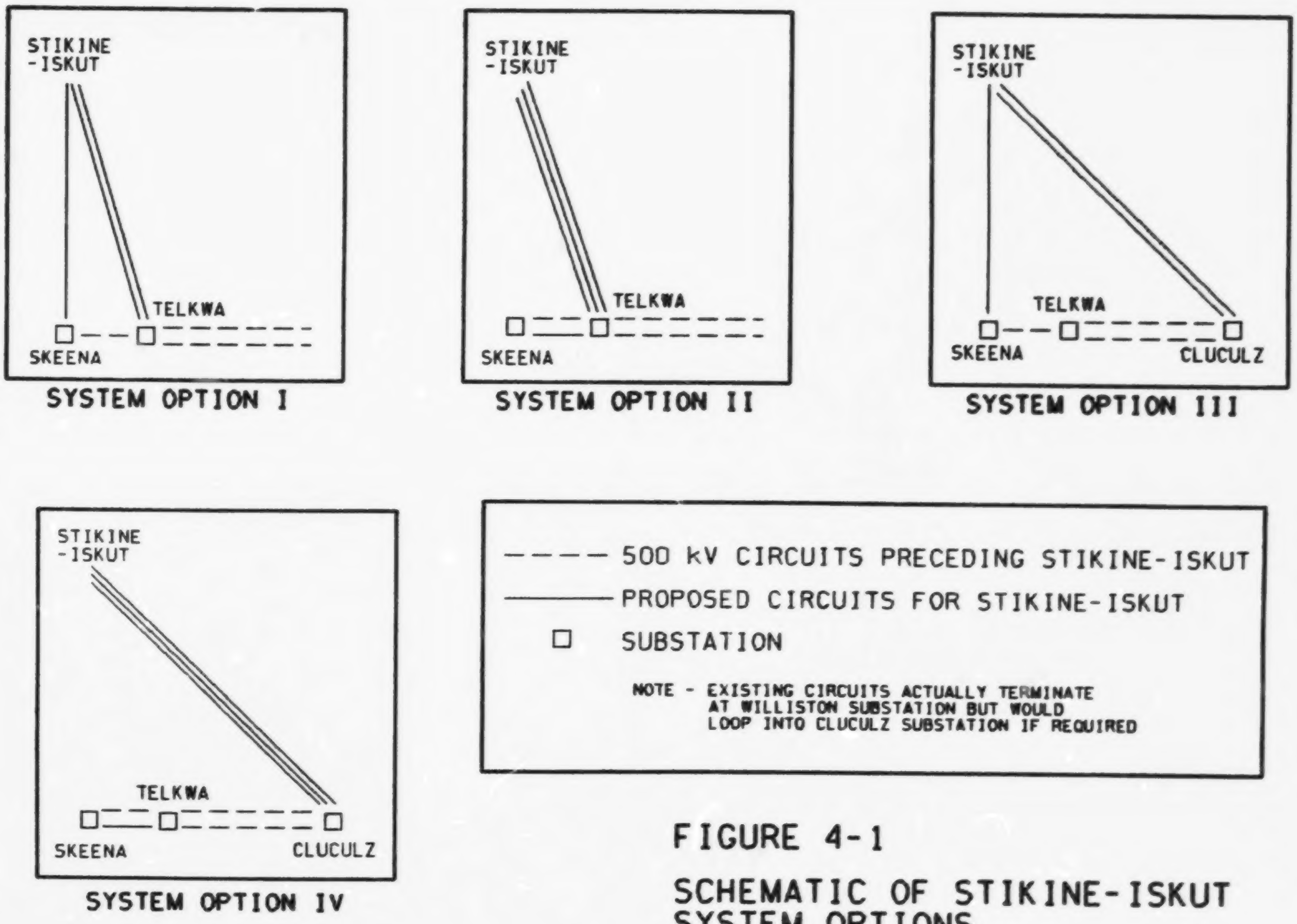

STIKINE
-ISKUT
TELKWA
SKEENA
SYSTEM OPTION I
STIKINE
-ISKUT
TELKWA
SKEENA
SYSTEM OPTION II
STIKINE
-ISKUT
TELKWA
SKEENA
CLUCULZ
SYSTEM OPTION III
STIKINE
-ISKUT
TELKWA
SKEENA
CLUCULZ
SYSTEM OPTION IV
500 kV CIRCUITS PRECEDING STIKINE-ISKUT
PROPOSED CIRCUITS FOR STIKINE-ISKUT
SUBSTATION
NOTE - EXISTING CIRCUITS ACTUALLY TERMINATE AT WILLISTON SUBSTATION BUT WOULD LOOP INTO CLUCULZ SUBSTATION IF REQUIRED

FIGURE 4-1

SCHEMATIC OF STIKINE-ISKUT SYSTEM OPTIONS

(BLANK)

5 Local Electrical Supply

The options discussed in Section 4 consider the transmission of power from the Stikine-Iskut generating stations to the system grid but do not specifically take into account the serving of local electrical loads.

There are two categories of existing or potential electric loads in the study area: district loads and industrial loads. District loads are residential, commercial and small industrial users that can be served at low voltages (25 kV or less). Industrial loads are heavy industrial users such as mines and wood processing complexes which require service at higher voltages (69 kV or more).

B.C. Hydro currently supplies district loads at Dease Lake, Eddontenajon, Telegraph Creek and Stewart from diesel generating stations. If the Stikine-Iskut development is built by B.C. Hydro, three of these communities (Dease Lake, Eddontenajon and Telegraph Creek) would receive, on or before completion of the development, the same provisions for electric service as communities connected to the B.C. Hydro integrated system.

Furthermore, other existing and potential communities in the area could also receive integrated system electric service if they qualify through the B.C. Hydro extension policy then in effect. Present extension policy is governed by the cost of providing an appropriate supply voltage at the closest appropriate electrical station, and of transmitting that voltage to the place of utilization.

Potential and existing industrial loads in the study area include Cassiar Asbestos, Schaft Creek Copper, Stikine Copper, Granduc Mines and others.

The provision of transformation and switching facilities to serve local district and industrial loads is being studied and evaluated as more becomes known about potential transmission line and station locations for the Stikine-Iskut development and the electric power requirements in the study area.

6 Summary of Preliminary Corridor Assessment Studies

6.1 General

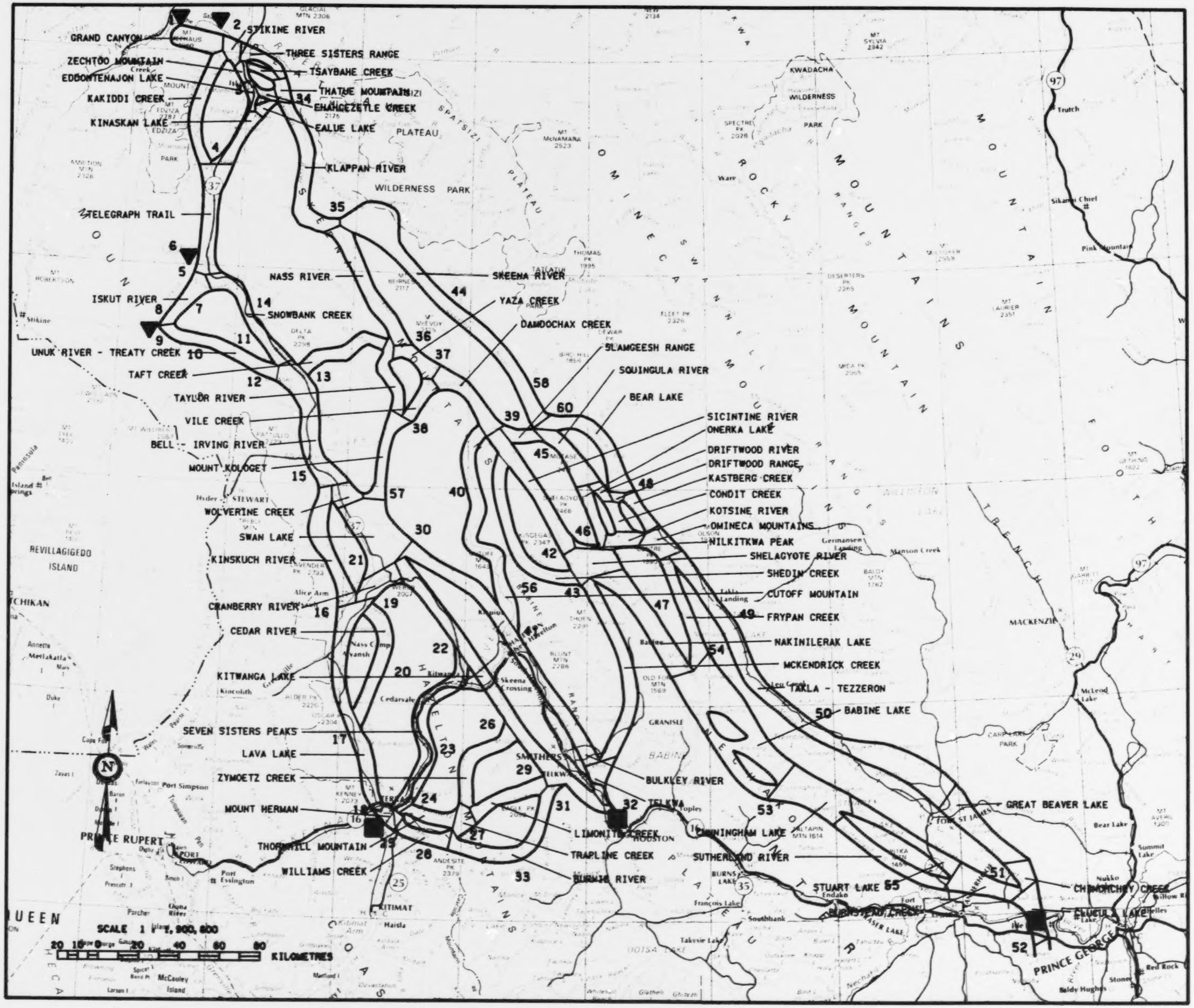
The preliminary planning studies of transmission line corridors for the Stikine-Iskut development were conducted by B.C. Hydro's Transmission Projects Division and by a team of environmental consultants co-ordinated by Ian Hayward and Associates. The results of these studies are reported in the Preliminary Route Engineering Assessment of the Stikine-Iskut Transmission System and in the Preliminary Environmental and Social Impact Assessment of the Stikine-Iskut Transmission System. These two reports are the primary source documents for this report and are summarized in this section.

The route engineering studies identified technically feasible transmission line corridors between the Stikine-Iskut generation sites and the possible destinations, and evaluated and ranked these corridors based on transmission line design, construction, security and cost criteria consistent with system requirements.

The environmental studies evaluated and compared the potential environmental impacts of constructing transmission lines along the technically feasible corridors, identified corridors with minimum environmental impact in the context of system requirements, ranked the corridor choices and suggested means to minimize potential environmental impacts. The environmental studies assessed potential impacts of the transmission project on agriculture, forestry, vegetation, terrain, fisheries, wildlife, recreation, visual resources, heritage resources, regional resource development, social and economic conditions and land use.

A discussion of the general social and environmental consequences of transmission line construction and operation is provided in Appendix II.

After the feasible corridors were identified, they were divided into manageable sections or segments to facilitate evaluation. The environmental and route engineering studies use different systems to label corridor segments in their reports. Figure 6-1 shows the corridors studied with both the environmental studies' segment names and boundaries and the engineering studies' segment numbers. The segment names in the environmental report are place names chosen from prominent topographic features that occur within or near the segments. The segment numbers in the route engineering report were assigned to points where there was a change in terrain or an intersection between two or more corridor segments. Segment labels used in the environmental and route engineering study summaries in this report are consistent with those used in the source reports.


GRAND CANYON
STIKINE RIVER
THREE SISTERS RANGE
ZECHTOO MOUNTAIN
TSAYBAHE CREEK
EDDONTENAJON LAKE
THATUE MOUNTAINS
KAKIDDI CREEK
EHAHCEZETLE CREEK
KINASKAN LAKE
EALUE LAKE
KLAPPAN RIVER
TELEGRAPH TRAIL
NASS RIVER
SKEENA RIVER
ISKUT RIVER
YAZA CREEK
SNOWBANK CREEK
DAMDOCHAX CREEK
UNUK RIVER - TREATY CREEK
SLAMGEESH RANGE
TAFT CREEK
SQUINGULA RIVER
TAYLOR RIVER
BEAR LAKE
VILE CREEK
SICINTINE RIVER
ONERKA LAKE
BELL - IRVING RIVER
DRIFTWOOD RIVER
DRIFTWOOD RANGE
MOUNT KOLOGET
KASTBERG CREEK
CONDIT CREEK
WOLVERINE CREEK
KOTSINE RIVER
OMINECA MOUNTAINS
SWAN LAKE
NILKITKWA PEAK
KINSKUCH RIVER
SHELAGYOTE RIVER
SHEDIN CREEK
CRANBERRY RIVER
CUTOFF MOUNTAIN
FRYPAN CREEK
CEDAR RIVER
NAKINILERAK LAKE
MCKENDRICK CREEK
KITWANGA LAKE
TAKLA - TEZZERON
BABINE LAKE
SEVEN SISTERS PEAKS
LAVA LAKE
ZYMOETZ CREEK
BULKLEY RIVER
TELKWA
MOUNT HERMAN
GREAT BEAVER LAKE
LIMONITE CREEK
CUNNINGHAM LAKE
THORNHILL MOUNTAIN
TRAPLINE CREEK
SUTHERLAND RIVER
WILLIAMS CREEK
BURNIE RIVER
STUART LAKE
CHINCHEGA CREEK
CLUCULZ LAKE
BURNSTEAD CREEK
PRINCE GEORGE
PRINCE RUPERT
SMITHERS
KITIMAT
STEWART
REVILLAGIGEDO ISLAND
SPATSIZI PLATEAU WILDERNESS PARK
KWADACHA WILDERNESS PARK
OMINECA MOUNTAINS
ROCKY MOUNTAINS
SWANNELL RANGES
ROCKY MOUNTAIN TRENCH
MOUNTAIN FOOTHILLS
HAZELTON MOUNTAINS
NECHAKO PLATEAU
MACKENZIE
N
SCALE 1 : 2,000,000
20 10 0 20 40 60 80 KILOMETRES
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
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51
52
53
54
55
56
57
58
60

FIGURE 6-1

STIKINE/ISKUT TRANSMISSION STUDIES

FEASIBLE CORRIDORS WITH SEGMENT NOMENCLATURE AND NUMBERING

■ SUBSTATION

▼ GENERATING STATION

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.

6.2 Summary of Environmental Corridor Assessment Studies

6.2.1 Environmental Impact Assessment

The preliminary environmental and social impact assessment studies for the Stikine-Iskut transmission project are part of the most complex transmission studies ever attempted in British Columbia. The vastness of the study area and the general lack of detailed information added to the difficulty of carrying out the environmental studies.

After consolidating available information and collecting new data in the field, each environmental study team member assessed the impact of transmission line construction along proposed corridors from the point of view of his/her individual, specialized subject matter, e.g., forestry or wildlife.

These specialized assessments are reported in detail in the source report in three regional volumes of corridor segment descriptions and evaluations.

After field studies were completed, the study team met for several days in order to compare their observations, to determine the relative importance of resources within each corridor and to assess the combined resource consequences of transmission line construction within the corridor. The consultants converted their individual results into a common rating system with eleven categories ranging from very substantial benefit to severely negative impact. These rating categories are used throughout the source environmental report in the consultants' basic descriptions and comparisons of the impacts. A more complete description of the assessment methods can be found in the environmental report.

The rating criteria for each environmental discipline, and the subsequent ratings are shown in Appendix V of this report. Ultimately, after considerable discussion, the study team consolidated its efforts by comparing corridor options and by recommending sets of preferred corridor segments. These sets represent a synthesis of individual, specialized concerns and priorities and of general group consensus. The environmental consultants' corridor preferences are outlined in this report and are discussed in detail in the first volume of the environmental report.

Regional summaries of the major environmental concerns, taken verbatim from volumes two, three and four of the environmental studies' report, follow. These summaries are general and do not necessarily represent B.C. Hydro's position with respect to potential impacts. Detailed information about each segment is available in the environmental studies' report. The regional divisions of the study area used by the consultants are shown in Figure 6-2.

6.2.2 Major Socioeconomic and Environmental Concerns

6.2.2.1 Stikine Plateau - Coast Mountains Region

[Taken verbatim from the environmental report]

Major Area Concerns

An area of major overall concern is the vicinity of Mount Edziza Park and Recreation Area. There may be some difficulty in avoiding the recreation area within the presently proposed Kakiddi Creek segment boundaries. There are concerns from a visual and recreational perspective, and the potential for heritage resources is particularly high in the Mount Edziza/Raspberry Pass area. Some of the best forest stands in the region are located there, as well as vulnerable populations of caribou, sheep and mountain goats which are presently protected by the lack of access. This area is utilized by members of the Tahltan and Iskut bands for hunting, trapping and subsistence activities.

Another area of overall concern is in the vicinity of Highway 37, particularly in the Snowbank Creek valley, but also near Kinaskan and Eddontenajon lakes. This highway is considered a prime wilderness recreation highway and is presently protected by a 10-chain reserve. In most areas in this region, the transmission lines could probably be screened from Highway 37. However, because of the steep narrow valley it appears to be impossible to screen even one transmission line from view along Snowbank Creek. Constricted topography may also make it very difficult to screen lines in the areas of Eddontenajon and Kinaskan lakes. Such visual intrusions would have significant effects on wilderness recreation activities. The Snowbank Creek valley also contains Ecological Reserve #59, which covers almost the entire width of the proposed corridor segment.

Major Discipline Concerns

From a wildlife perspective, there are two major areas of concern. The mountains east and south of Ealue and Kinaskan lakes have some of the highest value sheep and mountain goat range in B.C. The highest capability wildlife habitat in the entire study area occurs along the Klappan River where there is an abundant and diverse range of wildlife species.

The major area of fisheries concern is Bob Quinn Lake (which also has a park reserve), but also important are Kinaskan, Tatogga, Ealue and Eddontenajon lakes. The major concern from a vegetational perspective is the area of unique grasslands in the Stikine Canyon.

6.2.2.2 Nass Basin - Hazelton Mountains Region

[Taken verbatim from the environmental report]

Major Area Concerns

An area of major overall concern extends from the Aiyansh Lava Beds, Lava Lake and Kitsumkalum Lake, to Terrace. The lava beds are a beautiful recreational and tourist attraction, and substantial increases in future use are forecast with the possible establishment of a provincial park. There is a provincial park at the southeast end of Kitsumkalum Lake, which is also a popular recreational feature of this area. Terrain problems, particularly in the Tseax Valley may restrict opportunities to screen the lines from view. The entire corridor from Aiyansh to Terrace has varying amounts of settlement and land use and the potential for socioeconomic effects. There are also several highly productive fisheries, in particular, the Nass, Kiteen, Tseax, Kitsumkalum, and Skeena rivers. This area includes high value forest lands which are now under intensive forest management, and the land has good agricultural potential west of Terrace and north of Kitsumkalum Lake. Immediately east of Terrace are a number of narrow, steep valleys, which could present terrain difficulties for forestry and visual aspects, terminating in a small bench with intensive settlement and land use.

Another area of major concern is the Bulkley Valley, which contains some of the best agricultural land in northwestern B.C. There is fairly intensive settlement and land use, with most of the valley under cultivation, particularly in the vicinity of Telkwa. The Bulkley/Kispiox river system supports a sport fishery of international significance, and includes sensitive migration and spawning areas. The valley contains good forest growing sites and is an important area of integrated resource management.

The entire Skeena River and valley from the vicinity of Babiche Hill through to Terrace is an environmentally sensitive area. It was intensively utilized in the past and contains a number of important ethnographic village sites, and numerous other heritage sites. The potential for locating more heritage sites is high. The valley is still used extensively, particularly by native groups, who carry on traditional subsistence activities. The vicinity of Skeena Crossing is particularly heavily settled and utilized by native people. The Skeena River supports a major native food fishery, and tributaries of the Skeena have important salmon spawning areas. Most of the Skeena valley contains good forest growing sites with areas of extensive mature timber stands.

Major Discipline Concerns

Major areas of heritage concern besides those mentioned above, are the Nass River valley and the Cranberry River area. These were important trade and travel routes with a number of major villages and numerous resource utilization sites. In terms of wildlife, there are some scattered areas of critical moose winter range along the Bell-Irving River, and patches of vulnerable habitat in the Wolverine Creek/Swan Lake area. The quantity of moose winter range increases towards the south, with good habitat in many valleys in the Nechako Plateau.

The Babine River sport fishery is of international significance. In addition to those water systems previously mentioned, others of importance are Cranberry and Cedar rivers, Zymoetz and Telkwa river systems, Williams Creek and Lakelse Lake. Valuable forest land occurs in a number of areas in this region, including the Kitwanga Valley, Zymoetz Valley and the vicinity of McKendrick Creek. The latter is the only area in the entire study area where forestry operations can be conducted year-round.

6.2.2.3 Skeena Mountains-Nechako Plateau Region

[Taken verbatim from the environmental report]

Major Area Concerns

An area of major overall concern is the Skeena/Nass headwaters area, which has sensitive vegetation and delicate subalpine landscapes of high scenic distinction. This is one of the most attractive portions of the study area for wilderness recreation. The vicinity of the headwaters and the upper Nass and Skeena valleys have a high capability for a wide diversity of big game species.

The Driftwood Group is another area of concern, particularly around Bear Lake, which is an attractive visual feature. There was much ethnographic and historic activity around Bear Lake, which was the site of a fur trade post, Fort Connolly. The vicinity of Bear Lake contains significant populations of moose, goats and caribou, and people from the settlement at Bear Lake probably conduct a substantial amount of hunting and trapping. This area also has good forest growing sites and high quality timber stands.

The major lakes in the Nechako Plateau are also of some environmental concern, particularly Takla, Tezzeron, Babine, Cunningham and Stuart lakes. Several Indian bands use the lands in this area for hunting and trapping, and have important food fisheries on Takla, Tezzeron, Babine and Cunningham lakes; the latter two lakes have significant sport fisheries. Major salmon spawning and migration rivers are associated with these lakes. All of the larger lakes in the area have high recreational values for water-oriented activities and cottaging. Because of good access to the lakes and their location near existing parks and areas of settlement, recreational use levels are high. Heritage resources in the area are also significant, with intensive ethnographic and historic use. Major sites include Bulkley House on Takla Lake, Fort Kilmaurs on Babine Lake, and several ethnographic villages and historic trails throughout the area.

Major Discipline Concerns

In terms of wildlife resources, the Nakinilerak Lake - Frypan Creek - Omineca Mountains area has high capability moose winter range, nesting grounds for Canada geese and good mountain goat populations. The Chinohchey Creek - Cluculz Lake area has some of the highest capability moose habitat in the Fraser basin, as well as important moose and deer winter range. Many valleys in the Nechako Plateau have good ungulate habitat. The Babine River supports a steelhead sport fishery of international significance, and Morrison Lake is an important salmon producer. The Stuart River has among the most important sockeye runs in B.C. The Nechako River also has major salmon runs and supports a native food fishery and a sport fishery.

The Nechako Plateau-Fraser Basin have very high capability forest lands and good stands of mature timber, particularly lodgepole pine. There is presently extensive harvesting and ongoing silvicultural activities.

6.2.3 Comparison of Environmental Alternatives

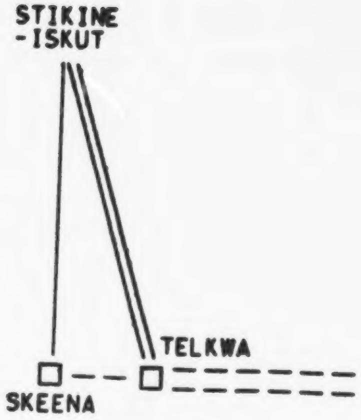
In addition to assessing the general overall impacts of locating transmission lines in specific corridor segments, the consultants considered the environmental and socio-economic consequences of the various transmission configurations and system options discussed in Section 4.0.

The frequency of high and severe potential impacts in the corridor segments was used as a basis for identifying corridors with the least potential for environmental impact. These were termed preferred corridors.

Alternatives A-H described below and shown in Figures 6-3(A) to 6-3(H) have the least environmental impact as determined by the consultants among the many possible combinations of corridor segments capable of satisfying B.C. Hydro's system requirements. The consultants offered these alternatives as the consolidated basis for comparison and evaluation of the socio-economic and environmental consequences of the transmission project.

The impact scores accompanying the descriptions of alternatives represent the frequency of high and severe impacts along the preferred corridors and facilitate a quantitative ranking of the alternatives.

SYSTEM OPTION I



Environmental Alternative A - refer to Figure 6-3 A

Impact Score 76; Corridor Length 662 km

The first alternative is based on the two Iskut circuits and two Stikine circuits joining at a collector near Bob Quinn Lake at the entrance to the Snowbank Creek segment. Three circuits run via the Bell-Irving River and Kitwanga Lake segments with one circuit branching off to Skeena via the Zymoetz Creek and Thornhill Mountain segments, and two proceeding on to Telkwa. This system results in the shortest transmission corridor length and has a relatively low impact. However, one single circuit and one double circuit transmission line along the Snowbank Creek segment could have a severe impact on the scenic resources and recreational use of Highway 37.

Environmental Alternative B - refer to Figure 6-3 B

Impact Score 80; Corridor Length 697 km

This is a minor adjustment to Alternative A. Instead of one single circuit line and a double circuit line, only one double circuit line goes via the Snowbank Creek segment, and two single circuit lines go via the Unuk River-Treaty Creek segment. They join at a collector near Wildfire Ridge. This is considered an acceptable alternative from an environmental perspective, but is longer and would have a greater environmental impact than alternative A.

Environmental Alternative C - refer to Figure 6-3 C

Impact Score 79; Corridor Length 802 km

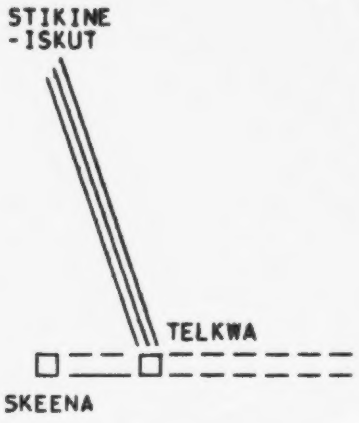
This alternative joins the Iskut and Stikine circuits at a collector near Swan Lake. The two Iskut circuits go via the Unuk-Treaty and Bell-Irving segments while the two Stikine circuits follow the Nass and Taylor river segments. From Swan Lake, this alternative is the same as A and B, with one single-circuit line going to Skeena via the Zymoetz Creek and Thornhill Mountain segments. This alternative is longer than A and B, but has a relatively low impact score.

Environmental Alternative D - refer to Figure 6-3 D

Impact Score 73; Corridor Length 770 km

In this alternative the two Iskut circuits continue along the Taft Creek segment from the Unuk River-Treaty Creek segments and join the Stikine circuits at a collector near the Muckaboo Creek-Nass River confluence. From there, three single-circuit lines run down the Taylor River segment to the Swan Lake segment. From this point, the alternative is identical to A, B and C. Alternative D is considered by the consultants to have the lowest overall environmental impact of all the alternatives.

SYSTEM OPTION II



Environmental Alternative E - refer to Figure 6-3 E

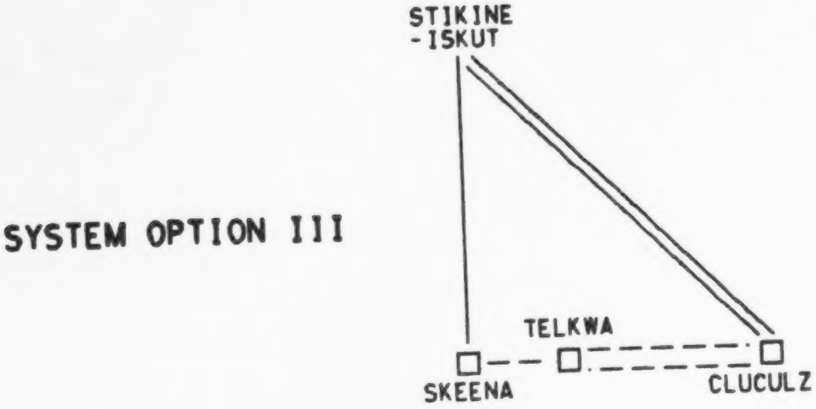
Impact Score 83; Corridor Length 707 km

This is a variation of B above except that three circuits run from a collector near Wildfire Ridge to Telkwa Substation. An additional single-circuit 500 kV line would be required between Telkwa and Skeena, via the Burnie River and Williams Creek segments. Although relatively short, the potential environmental impact would be higher than for alternatives A, B, C and D.

Environmental Alternative F - refer to Figure 6-3 F

Impact Score 73; Corridor Length 811 km

This alternative uses the Muckaboo collector and has three circuits running to Telkwa via the Sicintine and McKendrick Creek segments. The single circuit between Telkwa and Skeena follows the Burnie River and Williams Creek segments. This alternative is relatively long and has the same low impact score as Alternative D. However, because of Alternative F's length, the consultants slightly prefer Alternative D.

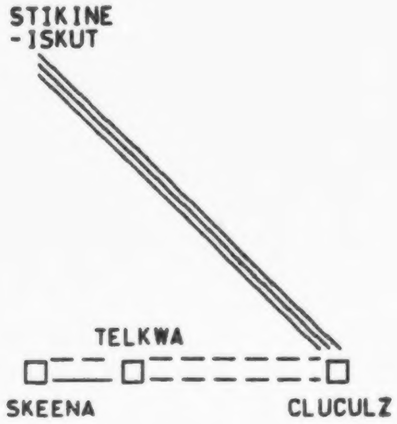


Environmental Alternative G - refer to Figure 6-3 G

Impact Score 111; Corridor Length 1102 km

With this alternative, the Stikine circuits follow the Nass River and Babine Lake segment string to Cluculz. One Iskut circuit joins the Stikine circuits at the Muckaboo collector and the other goes to Skeena via the

Kinskuch-Cedar-Lava Lake segments. Whether the Iskut circuit proceeds to Skeena via the Bell-Irving River or Taylor River corridors makes little difference. The Bell-Irving River option is more direct and is therefore the one chosen. This alternative would require the longest corridor length and is considered by the consultants to have the highest impact of all the alternatives considered.



SYSTEM OPTION IV

Environmental Alternative H - refer to Figure 6-3 H

Impact Score 97; Corridor Length 984 km

This is a variation of Alternative G. An additional circuit would be required between Telkwa and Skeena via the Burnie River and Williams Creek segments. Alternative H is shorter and would have less impact than alternative G. However, alternative H would result in more environmental impacts than alternatives A - F.

Summary

The least impact alternatives to Telkwa and Skeena have a significantly lower environmental and social impact than the least impact alternatives with Cluculz as a termination point.

The least impact alternatives to Telkwa and Skeena are D and F. D is slightly preferred because it is shorter than F. Alternative A is similar in potential impact to F and D.

The environmental consultants were unable to choose between alternatives A and F. Alternative A assumes three circuits through the Snowbank Creek segment. Indian reserves in the Kitwanga Lake segment could be difficult to avoid. On the other hand, alternative F would require much more new access. If some of that access is developed for forestry before this transmission development proceeds, Alternative F is preferred slightly over A.

The potential environmental impact of Alternatives B, C and E is higher than that of Alternatives A, D and F. Based on their impact scores Alternatives B and C are similar and preferred over Alternative E. Alternatives G and H have higher potential environmental impact than any of Alternatives A - E and G would have the highest of all.

In summary, the potential environmental impacts of Alternatives A, D and F are very similar. The environmental ranking of the alternatives is D, F, A, C, B, E, H, G.*

*Note: The estimated total cost of transmission line and station construction for the environmental alternatives is shown at the end of Appendix V.

6.2.4 Environmental Study Conclusions

A preferred alternative (Alternative D) was identified in order to meet the environmental study team's understanding of B.C. Hydro's system requirements and to minimize social and environmental impacts. This least impact alternative consists of two circuits from the Stikine generation sites to the Three Sisters Range, along the Klappan and Nass rivers to the Muckaboo collector; two circuits from the Iskut generation site, along the Unuk River-Treaty Creek and Taft Creek valleys to the Muckaboo collector, and three circuits from the Muckaboo collector, down the Taylor River valley, past Swan Lake and Kitwanga Lake to a point south of Kitseguecla River. From there, two circuits would proceed directly to Telkwa and one would go to Terrace along the Zymoetz River valley. This least impact alternative and the major areas of environmental concern are shown in Figure 6-4.

The Cluculz destination is not preferred because the greater transmission distances required are not balanced by suitable reductions in overall potential environmental impact.

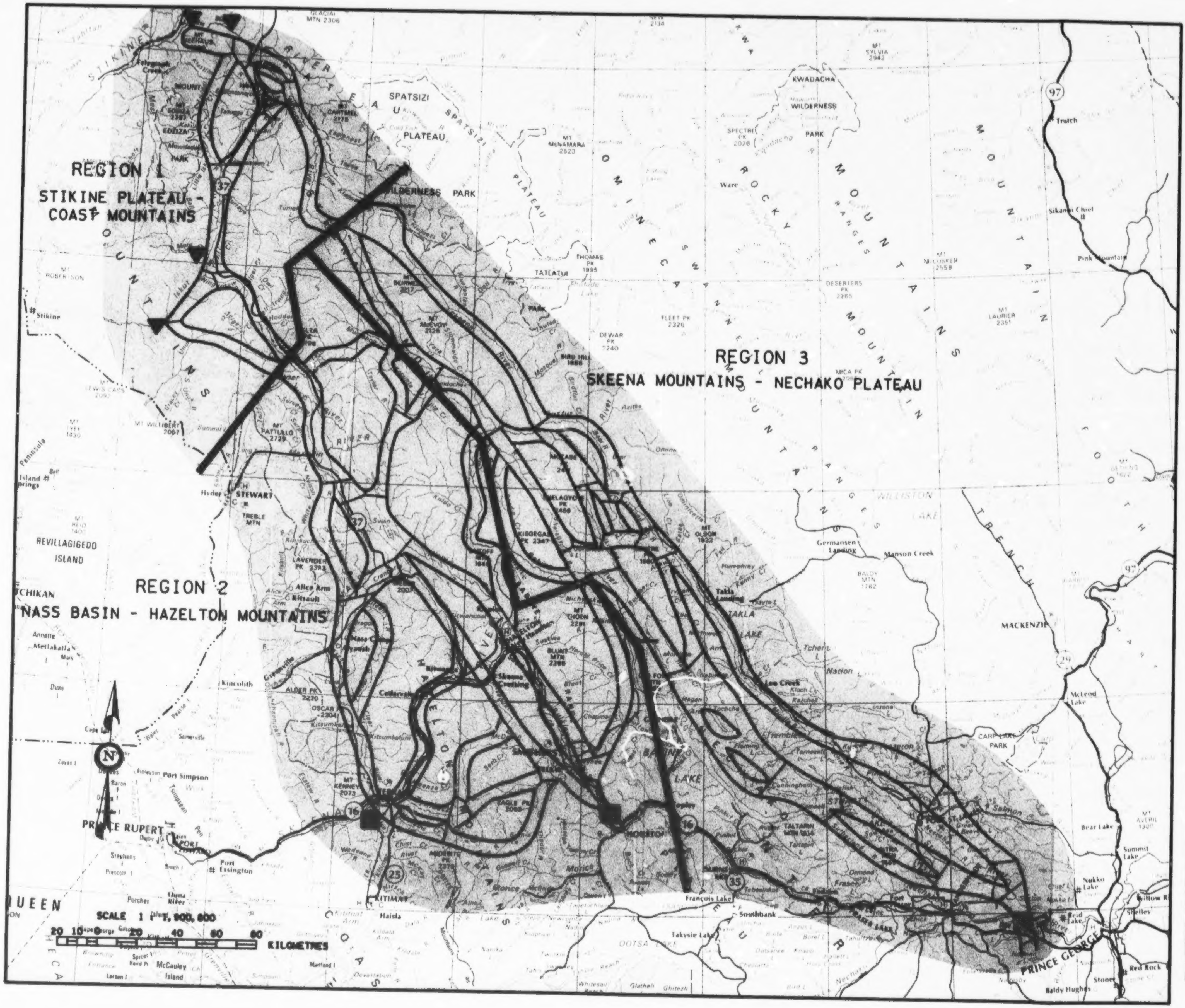

REGION 1
STIKINE PLATEAU - COAST MOUNTAINS
REGION 2
NASS BASIN - HAZELTON MOUNTAINS
REGION 3
SKEENA MOUNTAINS - NECHAKO PLATEAU
SPATSIZI PLATEAU WILDERNESS PARK
KWADACHA WILDERNESS PARK
OMINECA MOUNTAINS
SWANNELL RANGES
ROCKY MOUNTAINS
MUSKWA RANGES
ROCKY MOUNTAIN TRENCH
ROCKY MOUNTAIN FOOTHILLS
COAST MOUNTAINS
HAZELTON MOUNTAINS
STIKINE
STEWART
Hyder
REVILLAGIGEDO ISLAND
KETCHIKAN
PRINCE RUPERT
Port Simpson
KITIMAT
TERRACE
SMITHERS
HOUSTON
Francois Lake
Southbank
WILLISTON LAKE
Germansen Landing
Manson Creek
TAKLA LAKE
MACKENZIE
CARP LAKE PARK
PRINCE GEORGE
BABINE LAKE
Stuart Lake
Fraser Lake
Mcleod Lake
Bear Lake
Summit Lake
Baldy Hughes
Pink Mountain
Sikanni Chief
Trutch
37
16
25
35
97
N
SCALE 1 : 1,900,000
20 10 0 20 40 60 80
KILOMETRES

FIGURE 6-2

STIKINE/ISKUT TRANSMISSION STUDIES

REGIONAL DIVISIONS OF THE STUDY AREA

■ SUBSTATION

▼ GENERATING STATION

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.

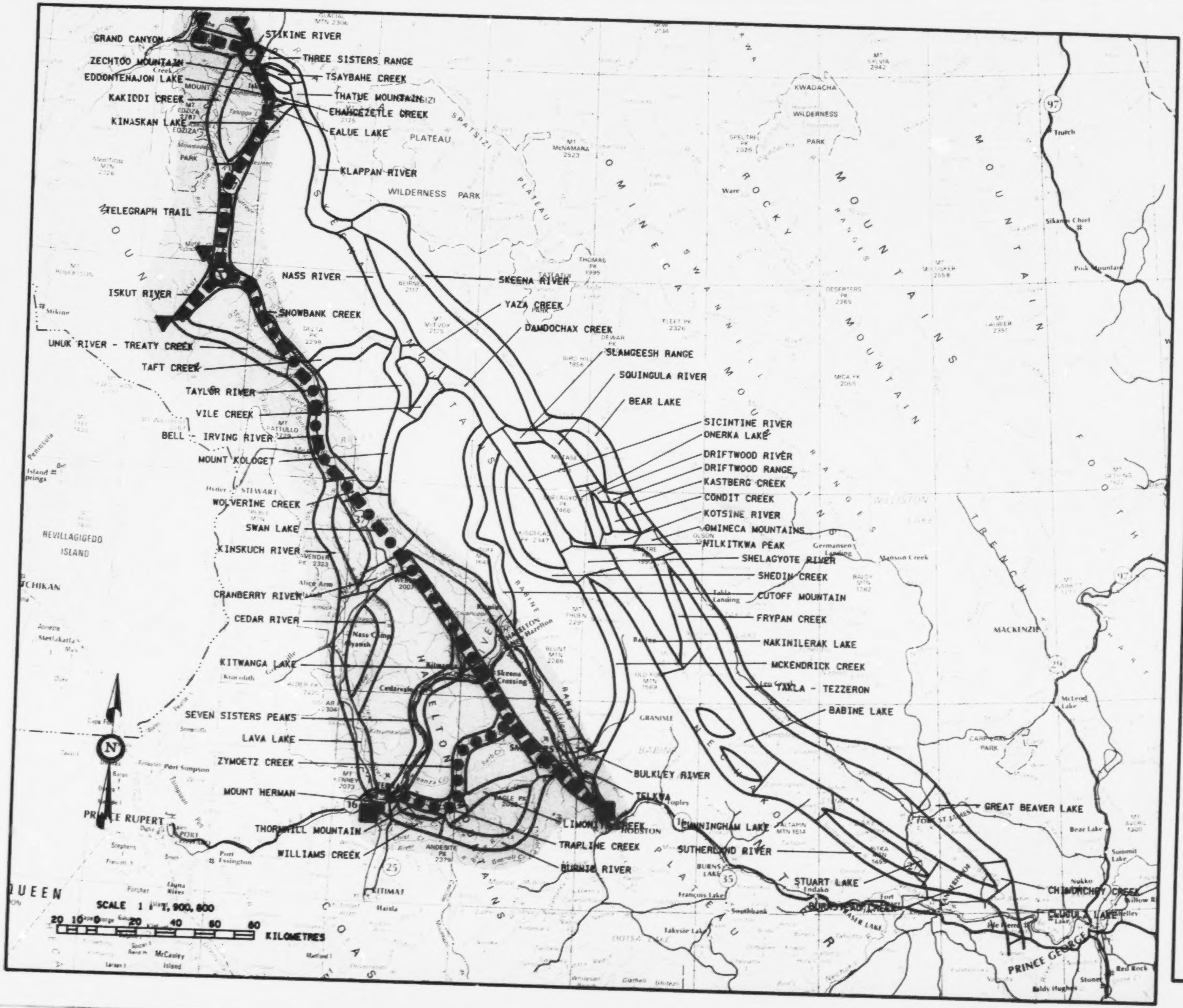

GRAND CANYON
STIKINE RIVER
THREE SISTERS RANGE
ZECHTOO MOUNTAIN
TSAYBAHE CREEK
EDDONTENAJON LAKE
THATUE MOUNTAIN
KAKIDDI CREEK
EHAHCEZETLE CREEK
KINASKAN LAKE
EALUE LAKE
SPATSIZI
PLATEAU
KLAPPAN RIVER
WILDERNESS PARK
TELEGRAPH TRAIL
NASS RIVER
SKEENA RIVER
ISKUT RIVER
YAZA CREEK
SNOWBANK CREEK
DAMDOCHAX CREEK
UNUK RIVER - TREATY CREEK
SLAMGEESH RANGE
TAFT CREEK
SQUINGULA RIVER
TAYLOR RIVER
BEAR LAKE
VILE CREEK
SICINTINE RIVER
BELL - IRVING RIVER
ONERKA LAKE
MOUNT KOLOGET
DRIFTWOOD RIVER
DRIFTWOOD RANGE
KASTBERG CREEK
WOLVERINE CREEK
CONDIT CREEK
KOTSINE RIVER
SWAN LAKE
OMINECA MOUNTAINS
NILKITKWA PEAK
KINSKUCH RIVER
SHELAGYOTE RIVER
SHEDIN CREEK
CRANBERRY RIVER
CUTOFF MOUNTAIN
CEDAR RIVER
FRYPAN CREEK
NAKINILERAK LAKE
KITWANGA LAKE
MCKENDRICK CREEK
TAKLA - TEZZERON
BABINE LAKE
SEVEN SISTERS PEAKS
LAVA LAKE
ZYMOETZ CREEK
BULKLEY RIVER
MOUNT HERMAN
TELKWA
LIMONITE CREEK
THORNHILL MOUNTAIN
CUNNINGHAM LAKE
TRAPLINE CREEK
SUTHERLAND RIVER
WILLIAMS CREEK
BURNIE RIVER
GREAT BEAVER LAKE
STUART LAKE
CHEMOMCHEY CREEK
CLUCULZ LAKE
PRINCE RUPERT
PRINCE GEORGE
REVILLAGIGEDO ISLAND
OMINECA
ROCKY MOUNTAINS
SWANNELL RANGES
MOUNTAINS
FOOTHILLS
TRENCH
NECHAKO PLATEAU
HAZELTON MOUNTAINS
SKEENA MOUNTAINS
COAST MOUNTAINS
N
SCALE 1 : 1,900,000
20 10 0 20 40 60 80
KILOMETRES

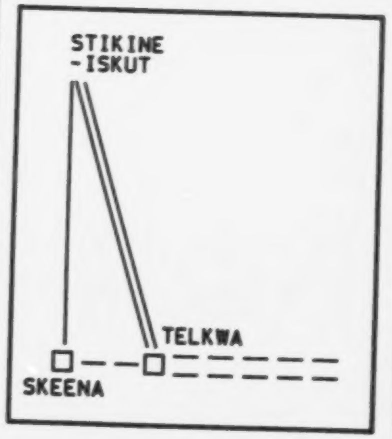
FIGURE 6-3 A

STIKINE/ISKUT TRANSMISSION STUDIES

ENVIRONMENTAL CORRIDOR PREFERENCE ALTERNATIVE A

●■● 3 CIRCUITS	500 kV
■■■ 2 CIRCUITS	500 kV
●●● 1 CIRCUIT	500 kV
▬	230 kV CIRCUIT
○	COLLECTOR STATION
■	SUBSTATION
▼	GENERATING STATION
	CORRIDORS CONSIDERED FOR ALTERNATIVE A

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.


STIKINE
-ISKUT
TELKWA
SKEENA

SYSTEM OPTION I

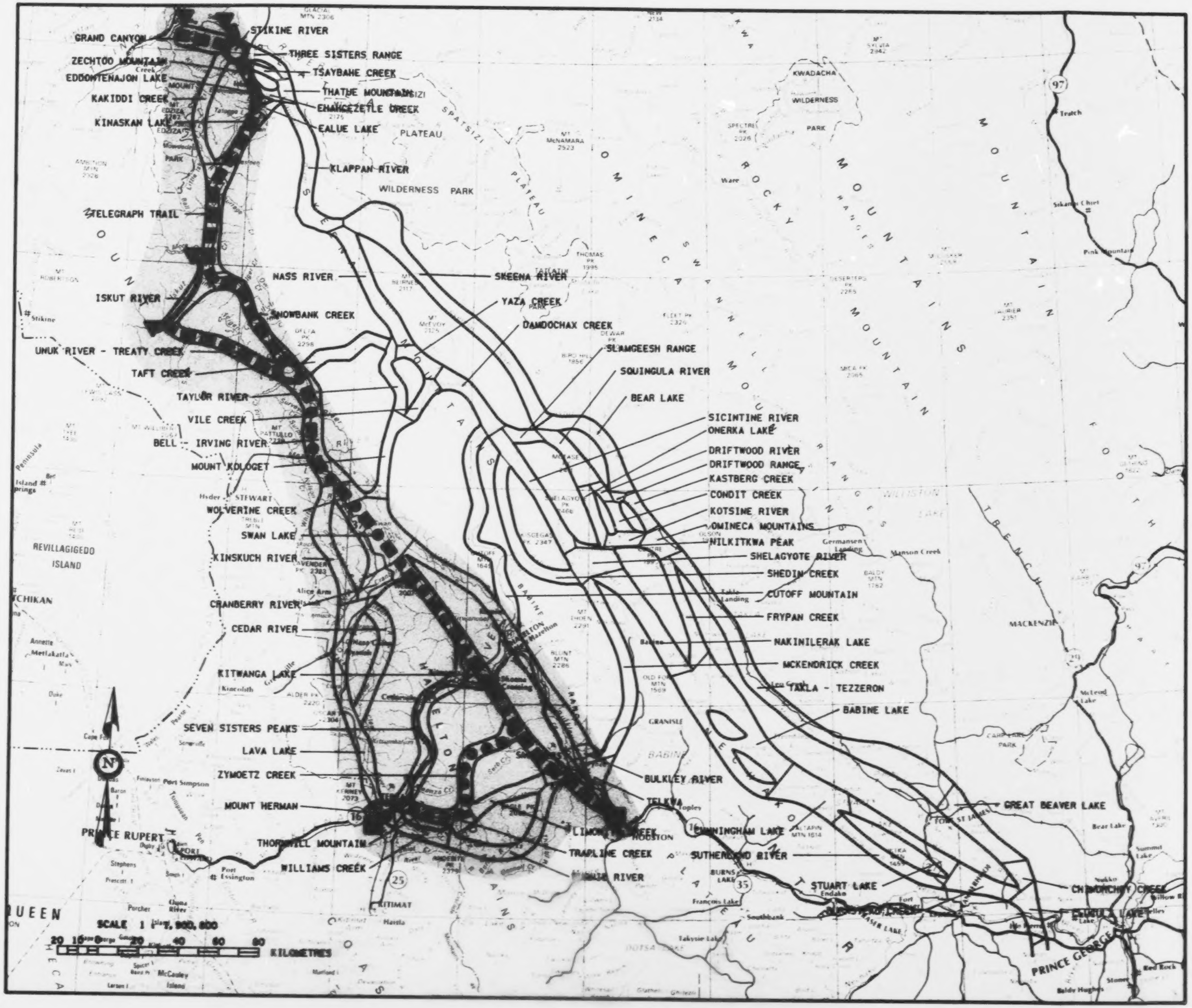

STIKINE RIVER
GRAND CANYON
THREE SISTERS RANGE
ZECHTOO MOUNTAIN
TSAYBAHE CREEK
EDDONTENAJON LAKE
THATUE MOUNTAIN
KAKIDDI CREEK
ENAHCEZETLE CREEK
KINASKAN LAKE
EALUE LAKE
PLATEAU
KLAPPAN RIVER
WILDERNESS PARK
TELEGRAPH TRAIL
NASS RIVER
SKEENA RIVER
ISKUT RIVER
YAZA CREEK
SNOWBANK CREEK
DAMDOCHAX CREEK
UNUK RIVER - TREATY CREEK
SLAMGEESH RANGE
TAFT CREEK
SQUINGULA RIVER
TAYLOR RIVER
BEAR LAKE
VILE CREEK
SICINTINE RIVER
BELL - IRVING RIVER
ONERKA LAKE
MOUNT KOLOGET
DRIFTWOOD RIVER
DRIFTWOOD RANGE
KASTBERG CREEK
STEWART
CONDIT CREEK
WOLVERINE CREEK
KOTSINE RIVER
OMINECA MOUNTAINS
SWAN LAKE
NILKITKWA PEAK
KINSKUCH RIVER
SHELAGYOTE RIVER
SHEDIN CREEK
CUTOFF MOUNTAIN
CRANBERRY RIVER
FRYPAN CREEK
CEDAR RIVER
NAKINILERAK LAKE
MCKENDRICK CREEK
KITWANGA LAKE
TAKLA - TEZZERON
BABINE LAKE
SEVEN SISTERS PEAKS
LAVA LAKE
BULKLEY RIVER
ZYMOETZ CREEK
TELKWA
MOUNT HERMAN
GREAT BEAVER LAKE
LIMONITE CREEK
CUNNINGHAM LAKE
THORNHILL MOUNTAIN
TRAPLINE CREEK
SUTHERLAND RIVER
WILLIAMS CREEK
KITIMAT
STUART LAKE
CHUBUNCHIY CREEK
PRINCE RUPERT
PRINCE GEORGE
REVILLAGIGEDO ISLAND
KETCHIKAN
SPATSIZI
OMINECA
SWANNELL
ROCKY MOUNTAIN TRENCH
MOUNTAINS
FOOTHILLS
KWADACHA WILDERNESS PARK
MACKENZIE
HAZELTON
HOUSTON
BURNS LAKE
SCALE 1 : 2,000,000
20 10 0 20 40 60 80 KILOMETRES
N

FIGURE 6-3 B

STIKINE/ISKUT TRANSMISSION STUDIES

ENVIRONMENTAL CORRIDOR PREFERENCE ALTERNATIVE B

● ■ ● 3 CIRCUITS
■ ■ ■ 2 CIRCUITS
● ● ● 1 CIRCUIT
} 500 kV

— 230 kV CIRCUIT

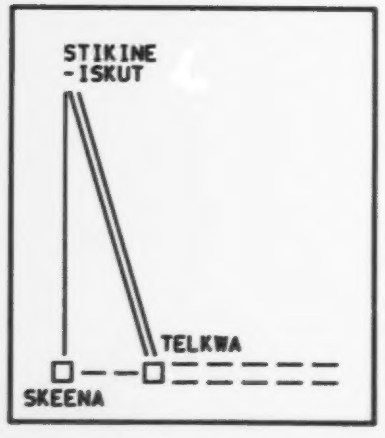
○ COLLECTOR STATION

■ SUBSTATION

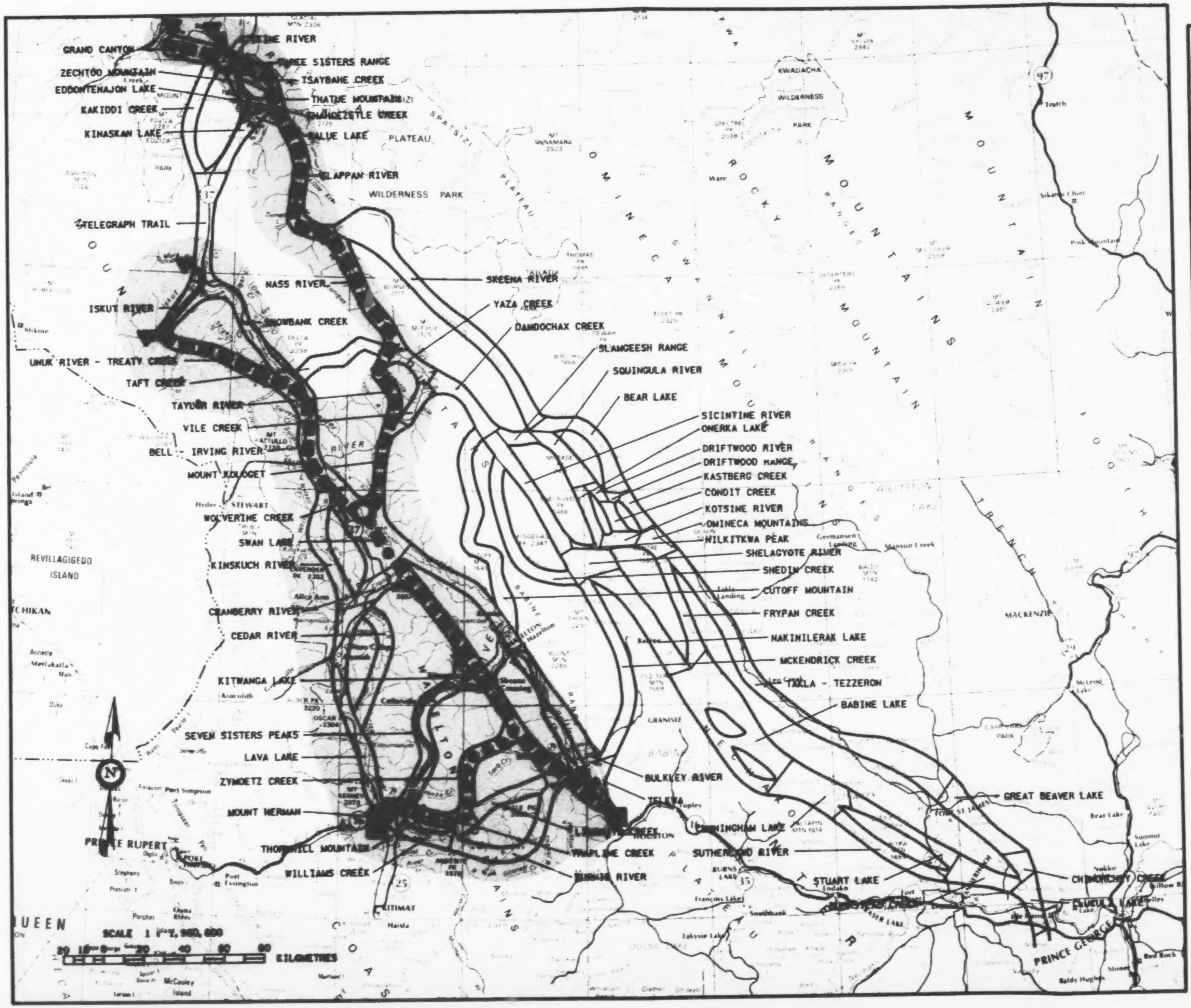
▼ GENERATING STATION

CORRIDORS CONSIDERED FOR ALTERNATIVE B

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.


STIKINE -ISKUT
TELKWA
SKEENA

SYSTEM OPTION I


GRAND CANYON
ZECHTOO MOUNTAIN
EDDONTENAJON LAKE
KAKIDDI CREEK
KINASKAN LAKE
TELEGRAPH TRAIL
ISKUT RIVER
UNUK RIVER - TREATY CREEK
TAFT CREEK
TAYLOR RIVER
VILE CREEK
BELL - IRVING RIVER
MOUNT KOLOGET
WOLVERINE CREEK
SWAN LAKE
KINSKUCH RIVER
CRANBERRY RIVER
CEDAR RIVER
KITWANGA LAKE
SEVEN SISTERS PEAKS
LAVA LAKE
ZYMOETZ CREEK
MOUNT HERMAN
THORNHILL MOUNTAIN
WILLIAMS CREEK
STIKINE RIVER
THREE SISTERS RANGE
TSAYBAHE CREEK
THATUE MOUNTAIN
CHANGEZETLE CREEK
BALUE LAKE
PLATEAU
KLAPPAN RIVER
WILDERNESS PARK
NASS RIVER
SNOWBANK CREEK
SKEENA RIVER
YAZA CREEK
DAMDOCHAX CREEK
SLAMGEESH RANGE
SQUINGULA RIVER
BEAR LAKE
SICINTINE RIVER
ONERKA LAKE
DRIFTWOOD RIVER
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KASTBERG CREEK
CONDIT CREEK
KOTSINE RIVER
OMINECA MOUNTAINS
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MCKENDRICK CREEK
TAKLA - TEZZERON
BABINE LAKE
BULKLEY RIVER
TELKWA
CUNNINGHAM LAKE
SUTHERLAND RIVER
STUART LAKE
GREAT BEAVER LAKE
CHILAKO CREEK
WHARLINE CREEK
MORICE RIVER
PRINCE RUPERT
KITIMAT
STEWART
PRINCE GEORGE
REVILLAGIGEDO ISLAND
MACKENZIE
OMINECA MOUNTAINS
ROCKY MOUNTAIN TRENCH
SCALE 1 : 1,950,000
20 10 0 20 40 60 80 KILOMETRES
N

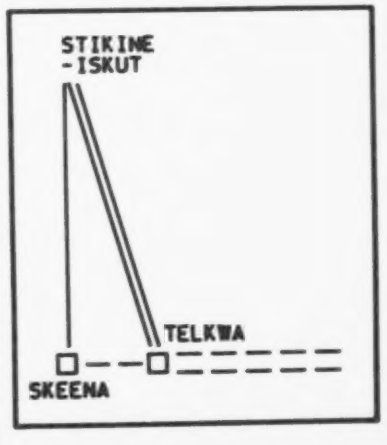
FIGURE 6-3 C

STIKINE/ISKUT TRANSMISSION STUDIES

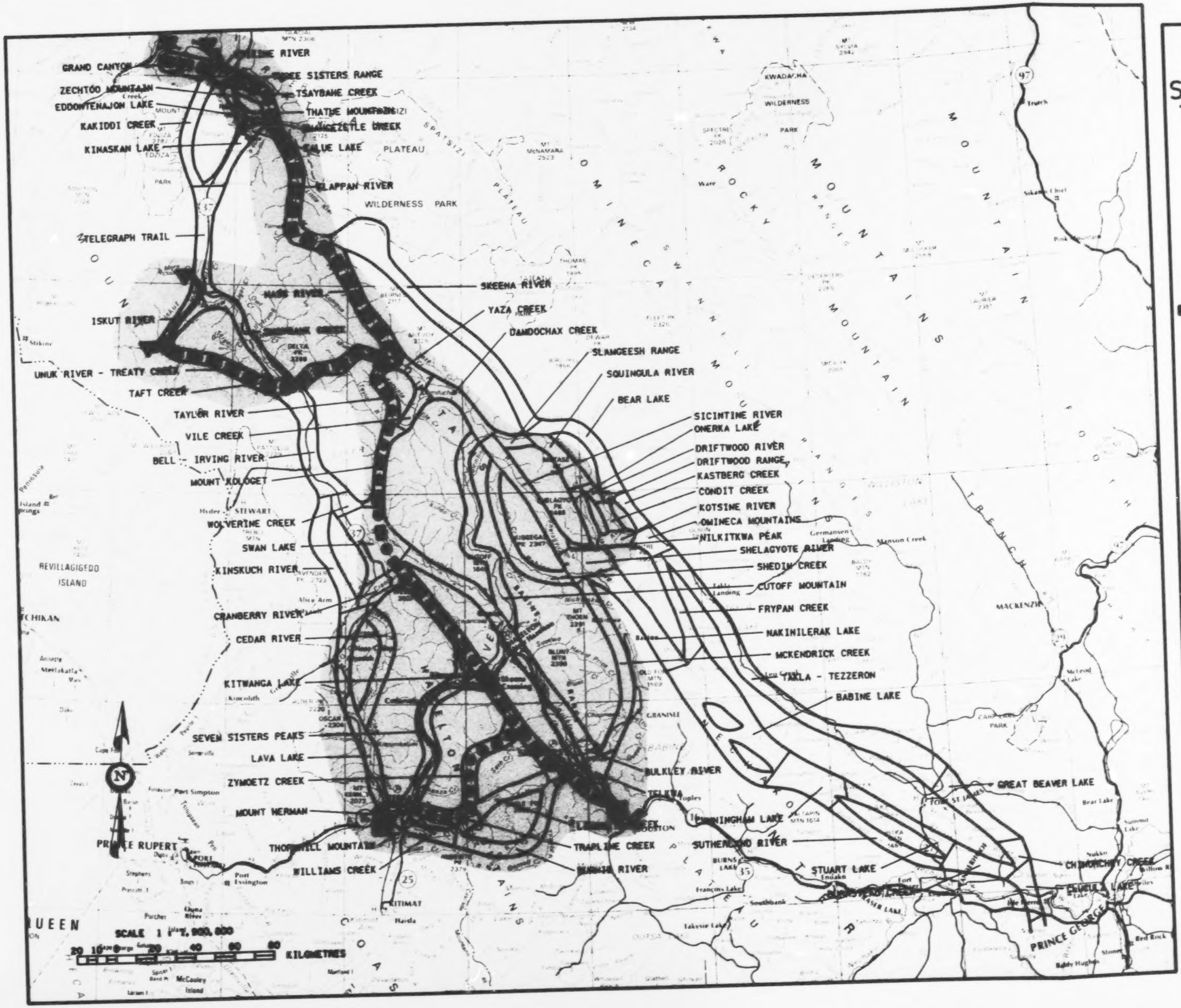
ENVIRONMENTAL CORRIDOR PREFERENCE ALTERNATIVE C

●■●	3 CIRCUITS	500 kV
■■■	2 CIRCUITS	500 kV
●●●	1 CIRCUIT	500 kV
▬	230 kV CIRCUIT	
○	COLLECTOR STATION	
■	SUBSTATION	
▼	GENERATING STATION	
	CORRIDORS CONSIDERED FOR ALTERNATIVE C	

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.


STIKINE -ISKUT
TELKWA
SKEENA

SYSTEM OPTION I


GRAND CANYON
STIKINE RIVER
THREE SISTERS RANGE
ZECHTOO MOUNTAIN
TSAYBAHE CREEK
EDDONTENAJON LAKE
THATHE MOUNTAIN
KAKIDDI CREEK
CHANCEZETLE CREEK
KINASKAN LAKE
KLUE LAKE
PLATEAU
SPATSIZI
KLAPPAN RIVER
WILDERNESS PARK
TELEGRAPH TRAIL
SKEENA RIVER
NASS RIVER
YAZA CREEK
ISKUT RIVER
DAMDOCHAX CREEK
SLAMGEESH RANGE
UNUK RIVER - TREATY CREEK
SQUINGULA RIVER
TAFT CREEK
BEAR LAKE
TAYLOR RIVER
SICINTINE RIVER
OMERKA LAKE
VILE CREEK
DRIFTWOOD RIVER
BELL - IRVING RIVER
DRIFTWOOD RANGE
KASTBERG CREEK
MOUNT KOLOGET
CONDIT CREEK
STEWART
KOTSINE RIVER
WOLVERINE CREEK
OMINECA MOUNTAINS
NILKITKWA PEAK
SWAN LAKE
SHELAGYOTE RIVER
KINSKUCH RIVER
SHEDIN CREEK
CUTOFF MOUNTAIN
REVILLAGIGEDO ISLAND
FRYPAN CREEK
CRANBERRY RIVER
NAKINILERAK LAKE
CEDAR RIVER
MCKENDRICK CREEK
TAKLA - TEZZERON
KITWANGA LAKE
BABINE LAKE
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TELKWA
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MOUNT HERMAN
CUNNINGHAM LAKE
TRAPLINE CREEK
THORNHILL MOUNTAIN
SUTHERLAND RIVER
PRINCE RUPERT
WILLIAMS CREEK
MORICE RIVER
STUART LAKE
CHICHONCHEY CREEK
PRINCE GEORGE
KITIMAT
OMINECA
ROCKY MOUNTAIN TRENCH
ROCKY MOUNTAINS
MACKENZIE
WILDERNESS PARK
N
SCALE 1 : 2,000,000
20 10 0 20 40 60 80 KILOMETRES

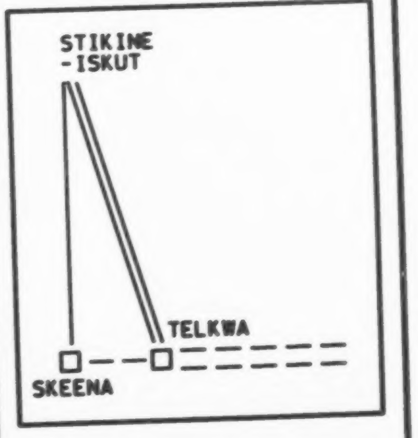
FIGURE 6-3 D

STIKINE/ISKUT TRANSMISSION STUDIES

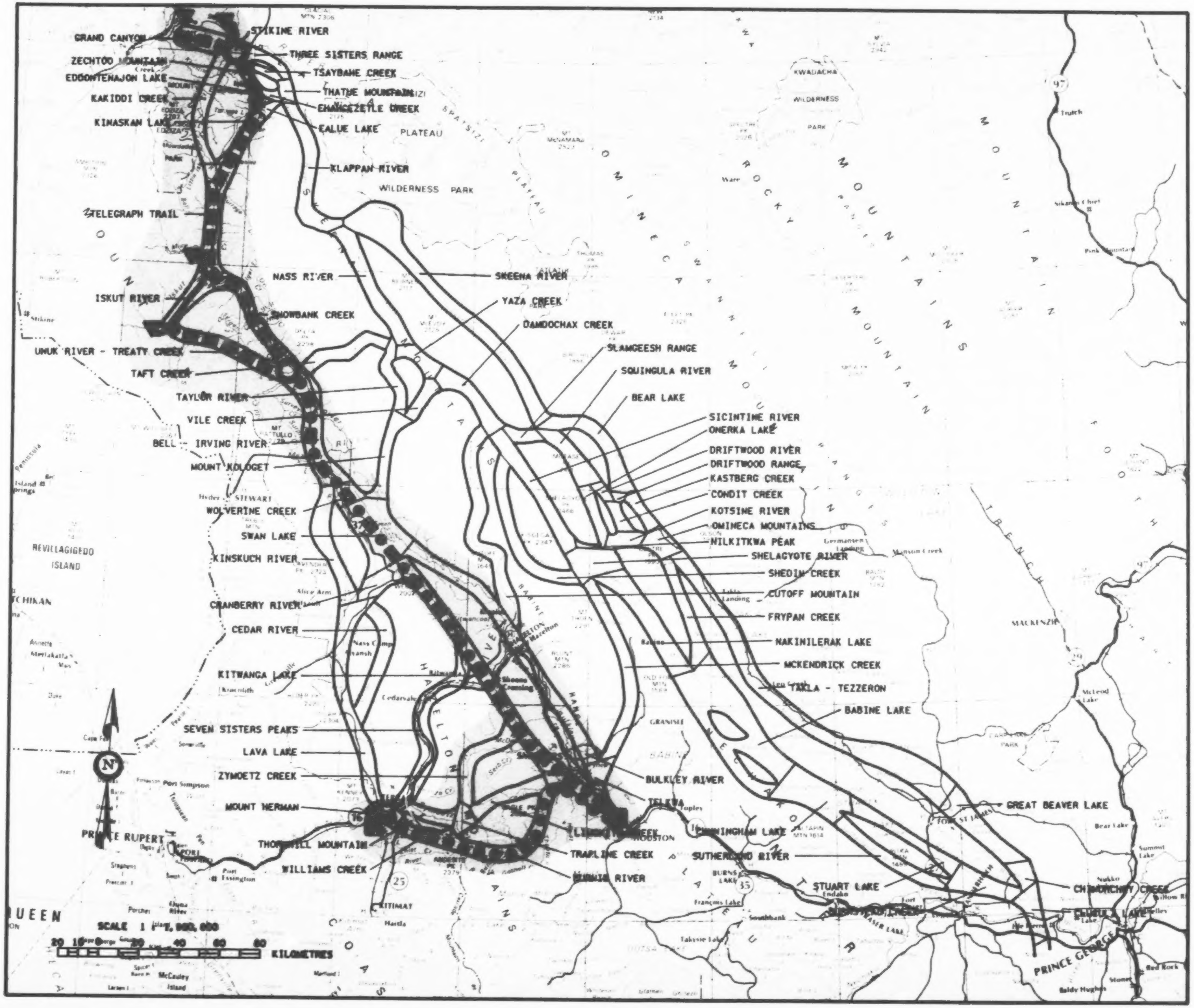
ENVIRONMENTAL CORRIDOR PREFERENCE ALTERNATIVE D

●■●	3 CIRCUITS	500 kV
■■■	2 CIRCUITS	500 kV
●●●	1 CIRCUIT	500 kV
▬	230 kV CIRCUIT	
○	COLLECTOR STATION	
■	SUBSTATION	
▼	GENERATING STATION	
▨	CORRIDORS CONSIDERED FOR ALTERNATIVE D	

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.


STIKINE -ISKUT
TELKWA
SKEENA

SYSTEM OPTION I


GRAND CANYON
STIKINE RIVER
ZECHTOO MOUNTAIN
THREE SISTERS RANGE
EDDONTENAJON LAKE
TSAYBAHE CREEK
KAKIDDI CREEK
THATUE MOUNTAIN
KINASKAN LAKE
EHAHCEZETLE CREEK
EALUE LAKE
PLATEAU
KLAPPAN RIVER
WILDERNESS PARK
TELEGRAPH TRAIL
NASS RIVER
SKEENA RIVER
ISKUT RIVER
YAZA CREEK
SNOWBANK CREEK
DAMDOCHAX CREEK
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SLAMGEESH RANGE
TAFT CREEK
SQUINGULA RIVER
TAYLOR RIVER
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VILE CREEK
SICINTINE RIVER
ONERKA LAKE
BELL - IRVING RIVER
DRIFTWOOD RIVER
DRIFTWOOD RANGE
MOUNT KOLOGET
KASTBERG CREEK
CONDIT CREEK
WOLVERINE CREEK
KOTSINE RIVER
OMINECA MOUNTAINS
SWAN LAKE
NILKITKWA PEAK
SHELAGYOTE RIVER
KINSKUCH RIVER
SHEDIN CREEK
CUTOFF MOUNTAIN
CRANBERRY RIVER
FRYPAN CREEK
CEDAR RIVER
NAKINILERAK LAKE
MCKENDRICK CREEK
KITWANGA LAKE
TAKLA - TEZZERON
BABINE LAKE
SEVEN SISTERS PEAKS
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GREAT BEAVER LAKE
MOUNT HERMAN
CUNNINGHAM LAKE
THORNHILL MOUNTAIN
TRAPLINE CREEK
SUTHERLAND RIVER
WILLIAMS CREEK
MORICE RIVER
STUART LAKE
CHILAKO CREEK
CHUNCHUM CREEK
PRINCE RUPERT
PRINCE GEORGE
REVILLAGIGEDO ISLAND
STEWART
KITIMAT
MACKENZIE
SCALE 1 : 2,000,000
20 10 0 20 40 60 80 KILOMETRES
N

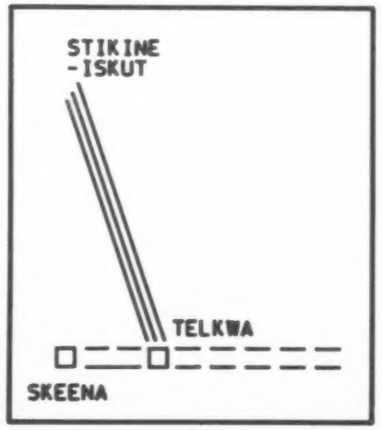
FIGURE 6-3 E

STIKINE/ISKUT TRANSMISSION STUDIES

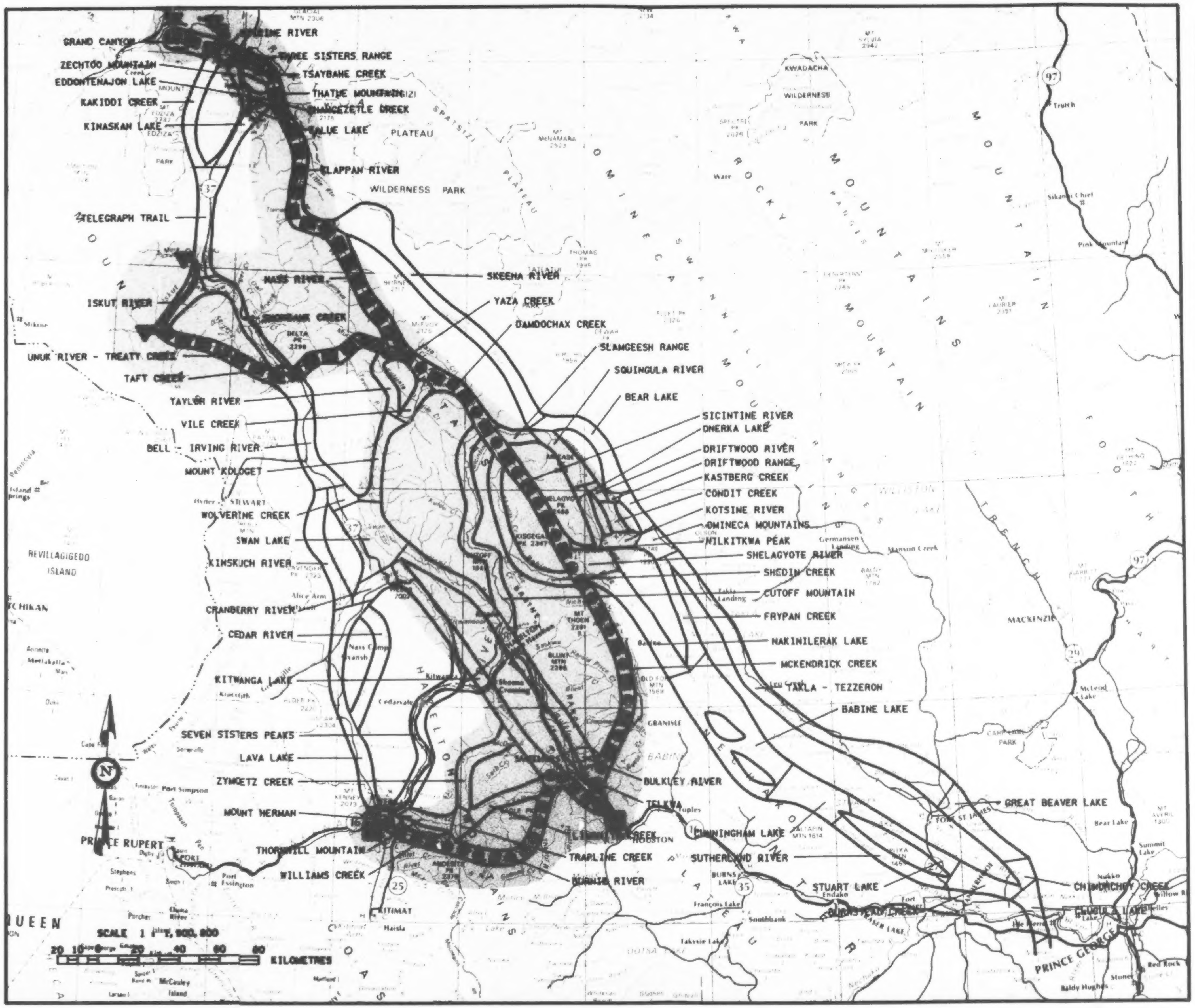
ENVIRONMENTAL CORRIDOR PREFERENCE ALTERNATIVE E

●■● 3 CIRCUITS
■■■ 2 CIRCUITS
●●● 1 CIRCUIT
500 kV
— 230 kV CIRCUIT
○ COLLECTOR STATION
■ SUBSTATION
▼ GENERATING STATION
CORRIDORS CONSIDERED FOR ALTERNATIVE E

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.


STIKINE
-ISKUT
TELKWA
SKEENA

SYSTEM OPTION II



GRAND CANYON
STIKINE RIVER
THREE SISTERS RANGE
ZECHTOO MOUNTAIN
TSAYBAHE CREEK
EDDONTENAJON LAKE
THATUE MOUNTAIN
KAKIDDI CREEK
CHANCEZETLE CREEK
KINASKAN LAKE
SALUE LAKE
PLATEAU
SPATSIZI
KLAPPAN RIVER
WILDERNESS PARK
TELEGRAPH TRAIL
NASS RIVER
SKEENA RIVER
ISKUT RIVER
BOWSER CREEK
YAZA CREEK
DAMDOCHAX CREEK
UNUK RIVER - TREATY CREEK
SLAMGEESH RANGE
TAFT CREEK
SQUINGULA RIVER
TAYLOR RIVER
BEAR LAKE
VILE CREEK
SICINTINE RIVER
ONERKA LAKE
BELL - IRVING RIVER
DRIFTWOOD RIVER
DRIFTWOOD RANGE
MOUNT KOLOGET
KASTBERG CREEK
CONDIT CREEK
WOLVERINE CREEK
KOTSINE RIVER
OMINECA MOUNTAINS
SWAN LAKE
NILKITKWA PEAK
SHELAGYOTE RIVER
KINSKUCH RIVER
SHEDIN CREEK
CUTOFF MOUNTAIN
CRANBERRY RIVER
FRYPAN CREEK
CEDAR RIVER
NAKINILERAK LAKE
MCKENDRICK CREEK
KITWANGA LAKE
TAKLA - TEZZERON
BABINE LAKE
SEVEN SISTERS PEAKS
LAVA LAKE
ZYMOETZ CREEK
BULKLEY RIVER
TELKWA
GREAT BEAVER LAKE
MOUNT HERMAN
CUNNINGHAM LAKE
THORNHILL MOUNTAIN
TRAPLINE CREEK
SUTHERLAND RIVER
WILLIAMS CREEK
BURNIE RIVER
STUART LAKE
CHINCHEY CREEK
PRINCE RUPERT
CLUCULZ LAKE
PRINCE GEORGE
REVILLAGIGEDO ISLAND
STEWART
KITIMAT
HOUSTON
OMINECA MOUNTAINS
ROCKY MOUNTAINS
MOUNTAIN TRENCH
HAZELTON MOUNTAINS
NECHAKO PLATEAU
N
SCALE 1 : 1,900,000
20 10 0 20 40 60 80 KILOMETRES
37
97
16
25
35
29
27
●■● 3 CIRCUITS
■■■ 2 CIRCUITS
●●● 1 CIRCUIT
500 kV
— 230 kV CIRCUIT
◎ COLLECTOR STATION
■ SUBSTATION
▼ GENERATING STATION
CORRIDORS CONSIDERED FOR ALTERNATIVE F
NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.
STIKINE -ISKUT
TELKWA
SKEENA
SYSTEM OPTION II

FIGURE 6-3 F

STIKINE/ISKUT TRANSMISSION STUDIES

ENVIRONMENTAL CORRIDOR PREFERENCE ALTERNATIVE F

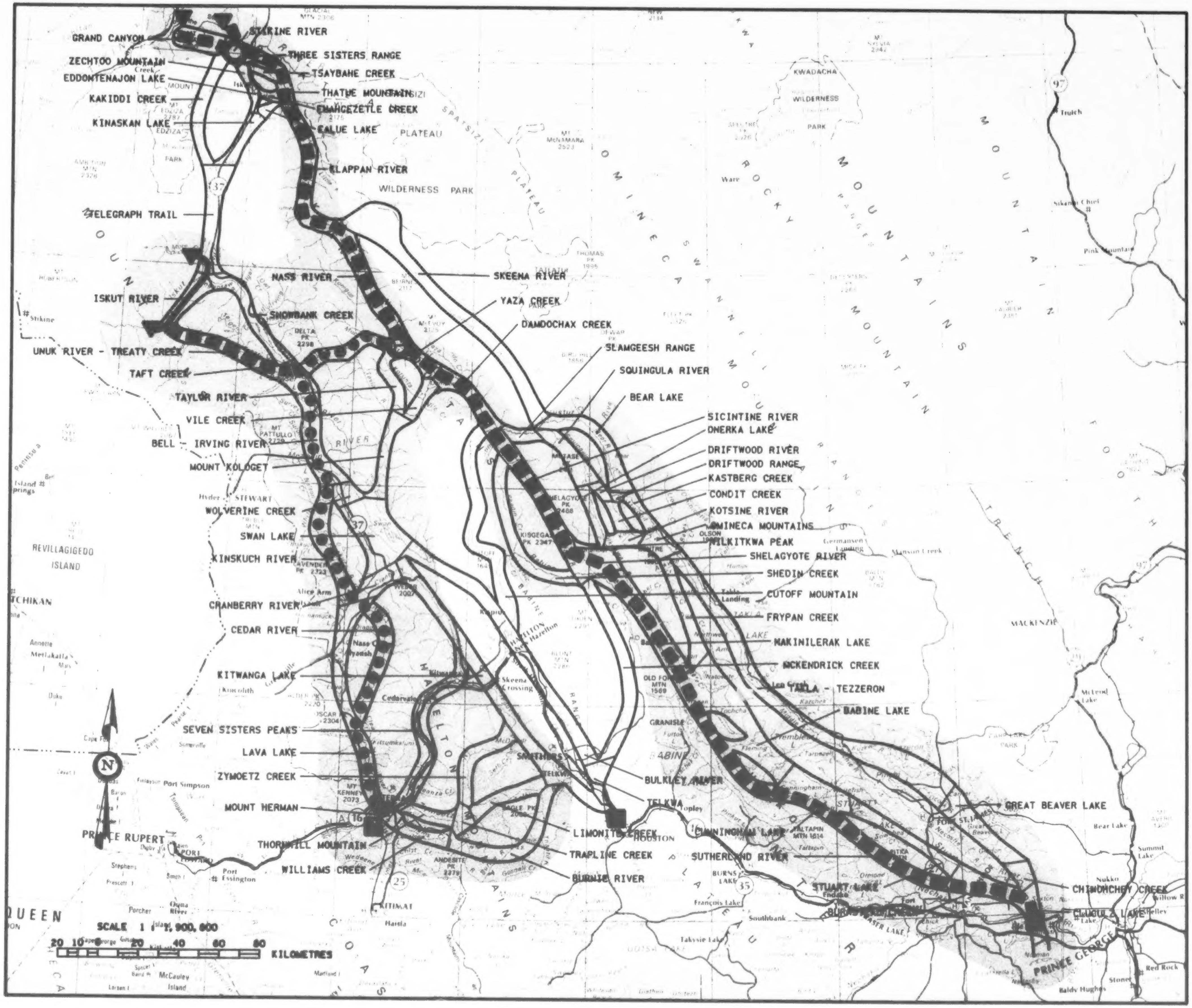

GRAND CANYON
STIKINE RIVER
THREE SISTERS RANGE
ZECHTOO MOUNTAIN
EDDONTENAJON LAKE
TSAYBAHE CREEK
THATUE MOUNTAIN
KAKIDDI CREEK
CHANCEZETLE CREEK
KINASKAN LAKE
KALUE LAKE
PLATEAU
KLAPPAN RIVER
WILDERNESS PARK
TELEGRAPH TRAIL
NASS RIVER
SKEENA RIVER
ISKUT RIVER
YAZA CREEK
SNOWBANK CREEK
DAMDOCHAX CREEK
UNUK RIVER - TREATY CREEK
SLAMGEESH RANGE
TAFT CREEK
SQUINGULA RIVER
TAYLOR RIVER
BEAR LAKE
VILE CREEK
SICINTINE RIVER
ONERKA LAKE
BELL - IRVING RIVER
DRIFTWOOD RIVER
DRIFTWOOD RANGE
MOUNT KOLOGET
KASTBERG CREEK
CONDIT CREEK
WOLVERINE CREEK
KOTSINE RIVER
OMINECA MOUNTAINS
SWAN LAKE
NILKITKWA PEAK
KINSKUCH RIVER
SHELAGYOTE RIVER
SHEDIN CREEK
CRANBERRY RIVER
CUTOFF MOUNTAIN
FRYPAN CREEK
CEDAR RIVER
MAKINILERAK LAKE
MCKENDRICK CREEK
KITWANGA LAKE
TAKLA - TEZZERON
BABINE LAKE
SEVEN SISTERS PEAKS
LAVA LAKE
SMITHERS
ZYMOETZ CREEK
BULKLEY RIVER
TELKWA
GREAT BEAVER LAKE
MOUNT HERMAN
LIMONITE CREEK
CUNNINGHAM LAKE
PRINCE RUPERT
THORNHILL MOUNTAIN
TRAPLINE CREEK
SUTHERLAND RIVER
WILLIAMS CREEK
BURNIE RIVER
STUART LAKE
CHINOHCHEY CREEK
CLUCULZ LAKE
PRINCE GEORGE
REVILLAGIGEDO ISLAND
N
SCALE 1 : 1,900,000
20 10 0 20 40 60 80
KILOMETRES

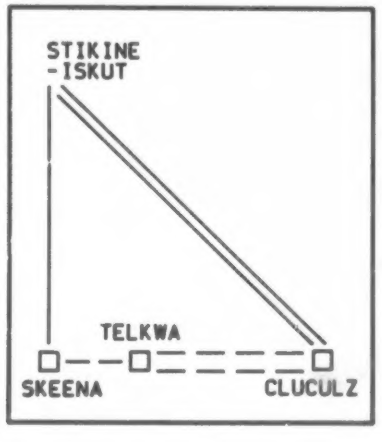
FIGURE 6-3 G

STIKINE/ISKUT TRANSMISSION STUDIES

ENVIRONMENTAL CORRIDOR PREFERENCE ALTERNATIVE G

■■■	2 CIRCUITS } 500 kV
●●●	1 CIRCUIT } 500 kV
—	230 kV CIRCUIT
○	COLLECTOR STATION
■	SUBSTATION
▼	GENERATING STATION
▨	CORRIDORS CONSIDERED FOR ALTERNATIVE G

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.


STIKINE -ISKUT
TELKWA
SKEENA
CLUCULZ

SYSTEM OPTION III

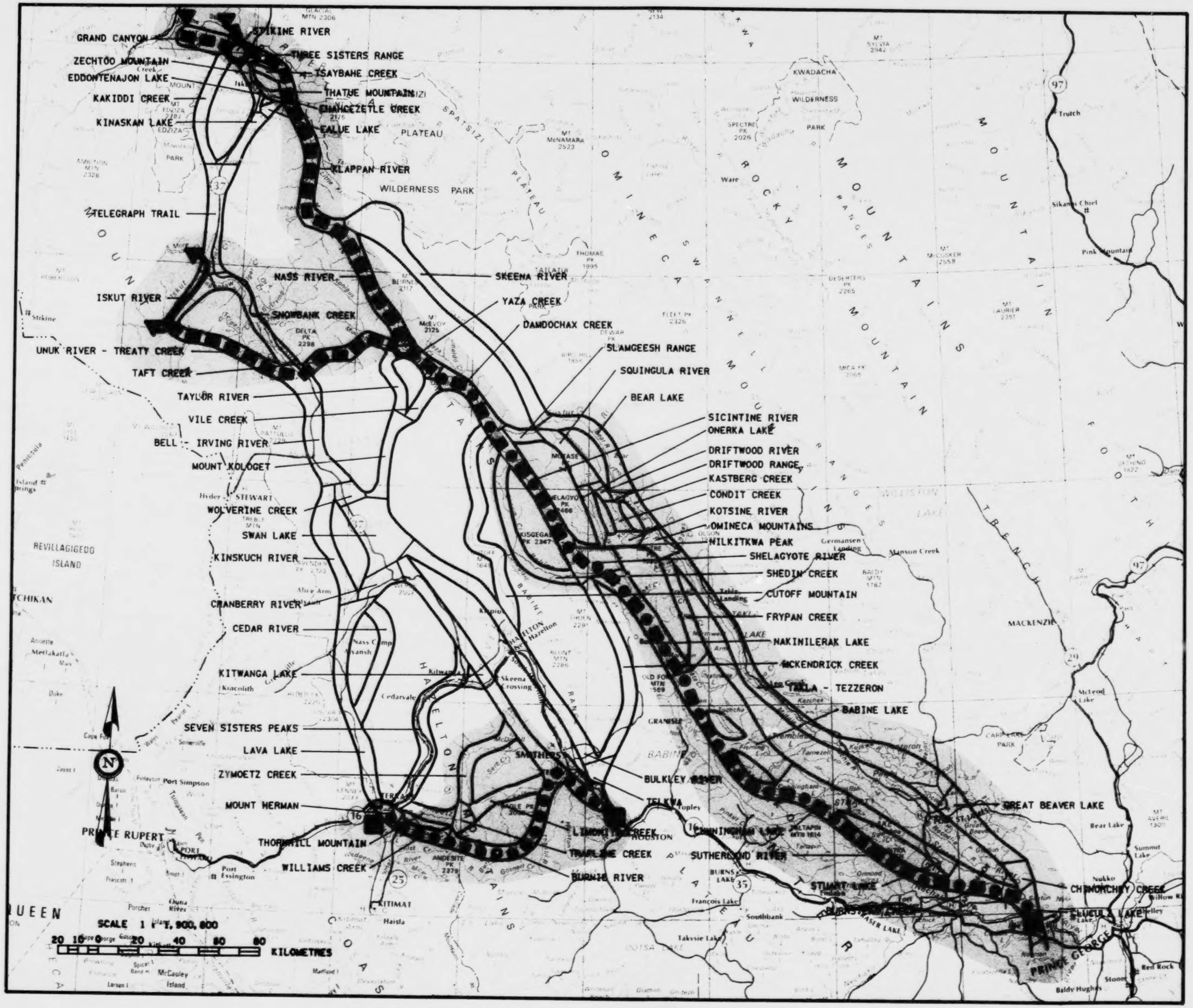

GRAND CANYON
STIKINE RIVER
ZECHTOO MOUNTAIN
THREE SISTERS RANGE
EDDONTENAJON LAKE
TSAYBAHE CREEK
KAKIDDI CREEK
THATUE MOUNTAIN
KINASKAN LAKE
CHANCEZETLE CREEK
EALUE LAKE
KLAPPAN RIVER
WILDERNESS PARK
SPATSIZI PLATEAU
TELEGRAPH TRAIL
NASS RIVER
SKEENA RIVER
ISKUT RIVER
SNOWBANK CREEK
YAZA CREEK
DAMDOCHAX CREEK
UNUK RIVER - TREATY CREEK
SLAMGEESH RANGE
TAFT CREEK
SQUINGULA RIVER
TAYLOR RIVER
BEAR LAKE
VILE CREEK
SICINTINE RIVER
ONERKA LAKE
BELL - IRVING RIVER
DRIFTWOOD RIVER
DRIFTWOOD RANGE
MOUNT KOLOGET
KASTBERG CREEK
CONDIT CREEK
WOLVERINE CREEK
KOTSINE RIVER
OMINECA MOUNTAINS
SWAN LAKE
NILKITKWA PEAK
KINSKUCH RIVER
SHELAGYOTE RIVER
SHEDIN CREEK
CUTOFF MOUNTAIN
CRANBERRY RIVER
FRYPAN CREEK
CEDAR RIVER
NAKINILERAK LAKE
MCKENDRICK CREEK
KITWANGA LAKE
TACLA - TEZZERON
BABINE LAKE
SEVEN SISTERS PEAKS
LAVA LAKE
SMITHERS
ZYMOETZ CREEK
BULKLEY RIVER
MOUNT HERMAN
TELKWA
GREAT BEAVER LAKE
LIMONITE CREEK
CUNNINGHAM LAKE
THORNHILL MOUNTAIN
TRAPLINE CREEK
SUTHERLAND RIVER
WILLIAMS CREEK
BURNIE RIVER
STUART LAKE
CHINORCHEY CREEK
CLUCULZ LAKE
PRINCE GEORGE
PRINCE RUPERT
KITIMAT
STEWART
HOUSTON
BURNS LAKE
OMINECA MOUNTAINS
ROCKY MOUNTAINS
SKEENA MOUNTAINS
HAZELTON MOUNTAINS
NECHAKO PLATEAU
SCALE 1 : 1,900,800
20 10 0 20 40 60 80 KILOMETRES
N

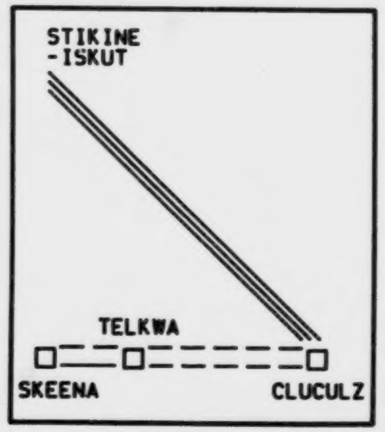
FIGURE 6-3 H

STIKINE/ISKUT TRANSMISSION STUDIES

ENVIRONMENTAL CORRIDOR PREFERENCE ALTERNATIVE H

●■●	3 CIRCUITS	500 kV
■■■	2 CIRCUITS	
●●●	1 CIRCUIT	
▬	230 kV CIRCUIT	
○	COLLECTOR STATION	
■	SUBSTATION	
▼	GENERATING STATION	
	CORRIDORS CONSIDERED FOR ALTERNATIVE H	

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.

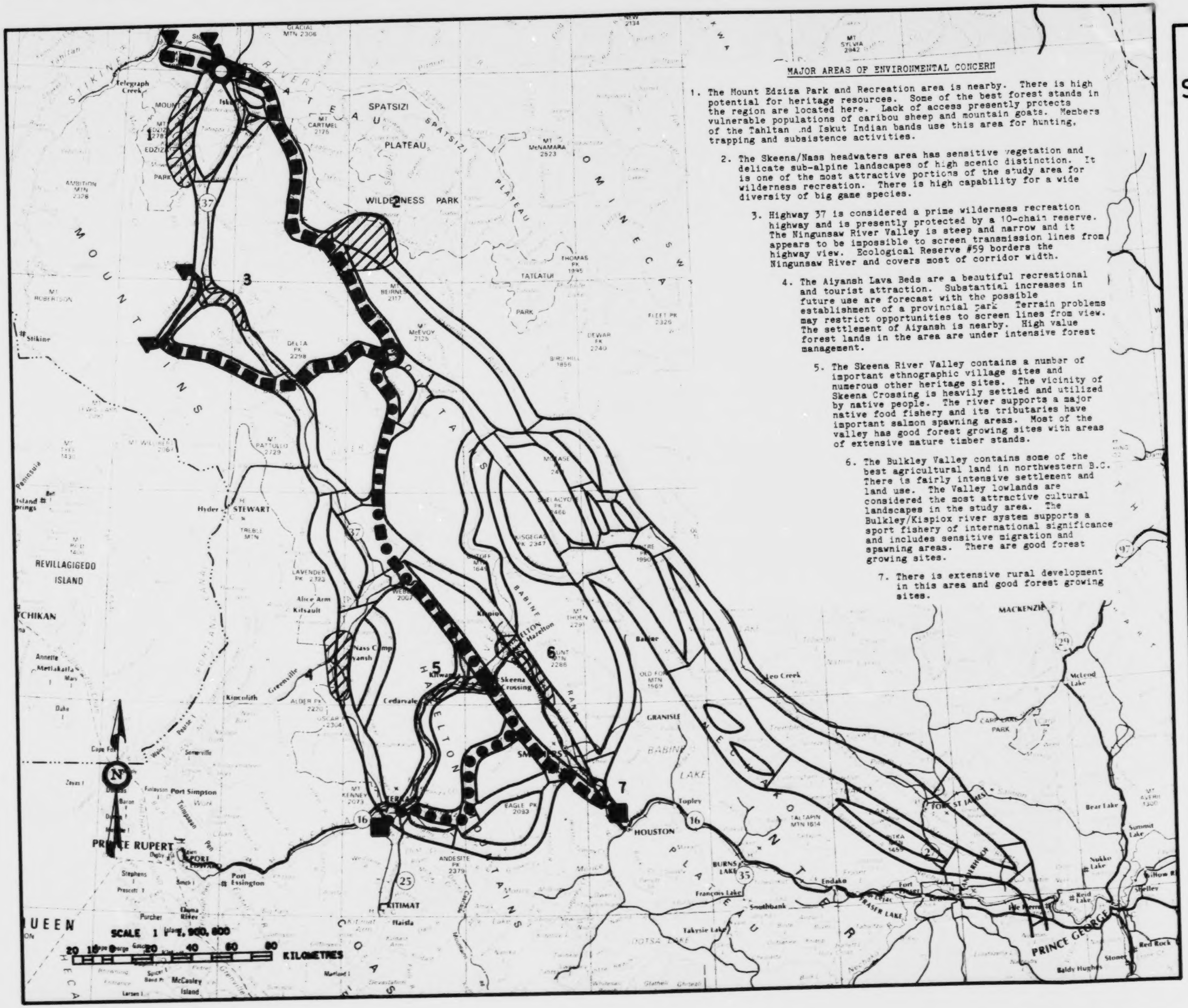

STIKINE -ISKUT
TELKWA
SKEENA
CLUCULZ

SYSTEM OPTION IV

FIGURE 6-4

STIKINE/ISKUT TRANSMISSION STUDIES

MAJOR AREAS OF ENVIRONMENTAL CONCERN AND LEAST IMPACT ALTERNATIVE (D)


STIKINE
Telegraph Creek
Iskut
MOUNT EDZIZA PARK
SPATSIZI PLATEAU WILDERNESS PARK
MT CARTMEL 2175
MT McNAMARA 2523
AMBITION MTN 2328
MT ROBERTSON
THOMAS PK 1995
TATLATUI PARK
MT BEIRNES 2117
MT McEVOY 2125
DELTA PK 2298
FLEET PK 2326
DEWAR PK 2240
BIRD HILL 1856
MT PATTULLO 2729
Hyder
STEWART
REVILLAGIGEDO ISLAND
LAVENDER PK 2392
Alice Arm
Kitsault
Nass Camp
Aiyansh
Greenville
Kincolith
ALDER PK 2220
Cedarvale
Kitwanga
Skeena Crossing
Hazelton
Kispiox
BABINE RANGE
HAZELTON MOUNTAINS
Babine
OLD FORT MTN 1569
GRANISLE
BABINE LAKE
Leo Creek
MACKENZIE
McLeod Lake
CARP LAKE PARK
FORT ST JAMES
Bear Lake
Summit Lake
Cape Fox
Port Simpson
PRINCE RUPERT
PORT EDWARD
Port Essington
MT KENNEY 2073
TERRACE
SMITHERS
EAGLE PK 2083
ANDESITE PK 2379
KITIMAT
Haisla
HOUSTON
Topley
BURNS LAKE
Francois Lake
Southbank
Endako
Fraser Lake
Fort Fraser
VANDERHOOF
PRINCE GEORGE
Stoner
Red Rock
Baldy Hughes
NECHAKO PLATEAU
OMINECA MOUNTAINS
COAST MOUNTAINS
37
16
25
35
27
29
97
1
2
3
4
5
6
7
N
SCALE 1 : 2,000,000
20 10 0 20 40 60 80 KILOMETRES
●■● 3 CIRCUITS
■■■ 2 CIRCUITS
●●● 1 CIRCUIT
500 kV
230 kV CIRCUIT
COLLECTOR STATION
SUBSTATION
GENERATING STATION
MAJOR AREAS OF ENVIRONMENTAL CONCERN
NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.

MAJOR AREAS OF ENVIRONMENTAL CONCERN

1. The Mount Edziza Park and Recreation area is nearby. There is high potential for heritage resources. Some of the best forest stands in the region are located here. Lack of access presently protects vulnerable populations of caribou sheep and mountain goats. Members of the Tahltan and Iskut Indian bands use this area for hunting, trapping and subsistence activities.

2. The Skeena/Nass headwaters area has sensitive vegetation and delicate sub-alpine landscapes of high scenic distinction. It is one of the most attractive portions of the study area for wilderness recreation. There is high capability for a wide diversity of big game species.

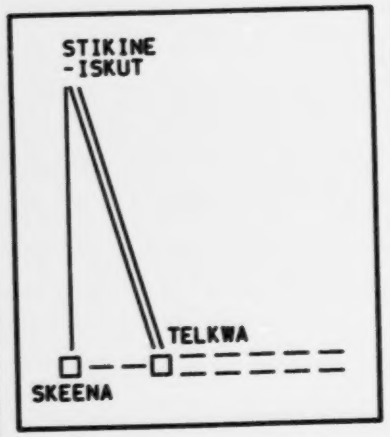
3. Highway 37 is considered a prime wilderness recreation highway and is presently protected by a 10-chain reserve. The Ningunsaw River Valley is steep and narrow and it appears to be impossible to screen transmission lines from highway view. Ecological Reserve #59 borders the Ningunsaw River and covers most of corridor width.

4. The Aiyansh Lava Beds are a beautiful recreational and tourist attraction. Substantial increases in future use are forecast with the possible establishment of a provincial park. Terrain problems may restrict opportunities to screen lines from view. The settlement of Aiyansh is nearby. High value forest lands in the area are under intensive forest management.

5. The Skeena River Valley contains a number of important ethnographic village sites and numerous other heritage sites. The vicinity of Skeena Crossing is heavily settled and utilized by native people. The river supports a major native food fishery and its tributaries have important salmon spawning areas. Most of the valley has good forest growing sites with areas of extensive mature timber stands.

6. The Bulkley Valley contains some of the best agricultural land in northwestern B.C. There is fairly intensive settlement and land use. The Valley lowlands are considered the most attractive cultural landscapes in the study area. The Bulkley/Kispiox river system supports a sport fishery of international significance and includes sensitive migration and spawning areas. There are good forest growing sites.

7. There is extensive rural development in this area and good forest growing sites.


STIKINE -ISKUT
TELKWA
SKEENA

SYSTEM OPTION I

6.3 Summary of Engineering Corridor Assessment Studies

The environmental studies have focused on the effect of transmission line construction, maintenance and operation on the environment. The engineering corridor assessment studies complement the environmental studies and are concerned primarily with transmission line length, cost and security. Steep and rugged terrain, severe climatic conditions, and long water crossings, for example, increase transmission line costs significantly. Areas sensitive to erosion or with steep side slopes or wet sections or where final appearance is critical may have to be cleared by hand at greater cost. Natural hazards such as avalanches, landslides, floods and erosion affect the security of transmission lines and must be avoided wherever possible. Transmission line construction costs and maintenance time and costs are significantly greater in areas with either poor or no access. Corridors that result in a transmission line of comparative excessive length also are not desirable due to higher construction and maintenance costs.

6.3.1 Technical Evaluation

Feasible corridors were evaluated by map and aerial photograph analysis and field reconnaissance both on the ground and from the air. Approximately 3900 km of potential transmission line corridors were investigated.

Several transmission schemes involving different collector station locations were developed for the possible system options presented. Corridor options within these schemes were compared on the basis of transmission line length, cost and security. A technically preferred corridor for each scheme was established. These corridors were compared and ranked. A corridor and scheme preferred overall was selected.

The corridor segments were evaluated on the basis of construction difficulty. Those factors that affect the cost of constructing a transmission line and the corridor segment ratings for each of these factors are tabulated in Appendix VI. Based on this evaluation, the costs of transmission line construction along the corridor segments were estimated and are tabulated in Appendix VI. These are direct costs based on actual 1981 construction cost figures for one, two and three single-circuit 500 kV lines. These cost estimates are intended for comparison purposes only.

Major hazards to transmission lines include snow avalanches, slope failures, landslides, debris flow and rockslides, floods and river erosion and ice and wind loadings. Each corridor segment was rated for these hazards. Security rating criteria and hazard ratings are set out in Appendix VI.

6.3.2 Specific Major Technical and Security Constraints

Significant technical and security constraints to transmission line location occur along several of the corridor segments being studied. Figure 6-6 identifies these areas and provides a brief summary of the technical concerns.

6.3.3 Comparison of Route Engineering Schemes

Figures 6-5(1) to 6-5(6) show the six transmission schemes considered, the corridors studied and the technical corridor preference for each scheme. A brief summary of reasons for exclusion of alternative corridors is included in these figures.

For all the schemes, it is highly preferable to use the Highway 37 corridor south of the Bob Quinn Lake area, where the highway provides good year-round access. (Segments 5 - 14 - 13). An avalanche overview study of this region concludes that two individual 500 kV transmission lines could be built along this corridor with acceptable security. Use of the alternative corridor (Segments 9 - 10 - 11 - 12) for transmission lines would present major construction, security and maintenance problems due to the avalanche risk, exposed upper elevations and lack of access.

The estimated total costs of transmission line and station construction along technically preferred corridors for each scheme are shown on Table 6-1.

TABLE 6-1

STIKINE-ISKUT TRANSMISSION STUDIES

ESTIMATED TOTAL COST FOR ROUTE ENGINEERING SCHEMES

System Option	Route Engineering Scheme	Route Length (km)*1	Circuit Length (km)	Direct Transmission Cost Estimate ($ Million)*2	Direct Stations Cost Estimate ($ Million)*2	Total Scheme Cost Estimate ($ Million)*3
I	1	787	1479	608	103	3059
	2	1002	1648	696	86	3533
II	3	693	1653	654	109	3306
	4	956	1822	735	103	3791
III	5	1237	2022	798	136	4187
IV	6	1044	2657	989	169	5164

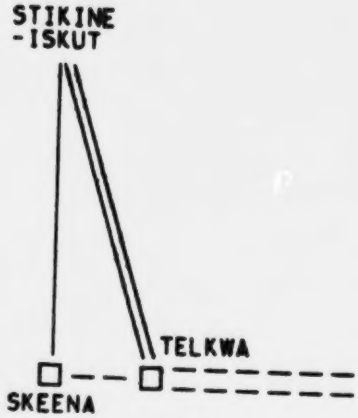
---

*1 Route lengths are based on the determination of an approximate route within the corridors. Because the routes are not straight lines, they tend to be slightly longer than the corridors.

*2 The direct cost estimates are in 1981 dollars.

*3 The total cost estimate includes inflation, corporate overhead and interest during construction based on in-service dates for More Creek and Iskut Canyon of 1993, and for Stikine Canyon and Tanzilla of 1995 and 1997 respectively. It does not include annual costs such as line losses, operating and maintenance which are incurred after the line is in-service.

SYSTEM OPTION 1



Route Engineering Scheme 1 - refer to Figure 6-5 (1)

This scheme considers interconnection of the Stikine and Iskut transmission circuits at a collector station in the vicinity of Bob Quinn Lake. One single circuit and one double-circuit 500 kV transmission line would be necessary south of the collector along the Ningunsaw River, Beaverpond and Snowbank creeks (Segment 5 - 14) in consideration of avalanche risks. Three single-circuit 500 kV lines would be constructed south of point 14.

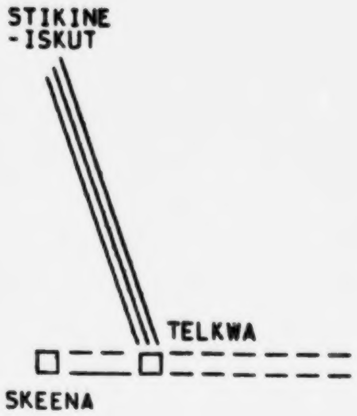
The single transmission line proceeding directly to Skeena Substation could be routed to avoid the lava beds in the Nass and Tseax rivers area. (Segment 16 - 17). Use of the technically preferred corridors for Scheme 1 would require the smallest amount of new transmission line construction, (1479 km) and the least estimated overall cost ($3,059 million) of all the schemes.

Route Engineering Scheme 2 - refer to Figure 6-5 (2)

This scheme considers interconnection of the Stikine and Iskut transmission circuits at a collector station near the confluence of Muckaboo Creek and the Nass River.

The technically preferred corridor from the Stikine collector to this collector joins the valley of the Klappan east of Kluachan Lake and follows the valley to the headwaters of the Klappan, Skeena and Nass rivers. It then follows the Nass River to Muckaboo Creek. The lack of good access along much of the corridor length would create construction and maintenance difficulties. (Segments 2 - 3 - 34 - 35 - 36). One of the two circuits from Iskut Canyon must follow the Taft Creek valley to interconnect with the Stikine-Iskut circuits, (Segment 13 - 36). There is potential for high winds, icing, unstable soils and avalanches along this segment and currently no access exists. Use of the technically preferred corridors for Scheme 2 would require 1653 km of transmission line construction at an overall cost of $3,533 million.

SYSTEM OPTION II



Route Engineering Scheme 3 - refer to Figure 6-5 (3)

The technically preferred corridor for this scheme is the same as for Scheme 1 to the Swan Lake area (pt. 21), where instead of one circuit branching off to Skeena Substation, all three circuits go to Telkwa Substation. The technically preferred corridor for the additional 500 kV circuit required between these substations to back up the Terrace-Prince Rupert area follows the existing transmission line from Telkwa Substation over Telkwa Pass (32 - 31 - 29 - 27), then swings southwest along Williams Creek to Skeena Substation (28 - 25 - 18). This avoids the congested area near the Zymoetz River-Skeena River confluence.

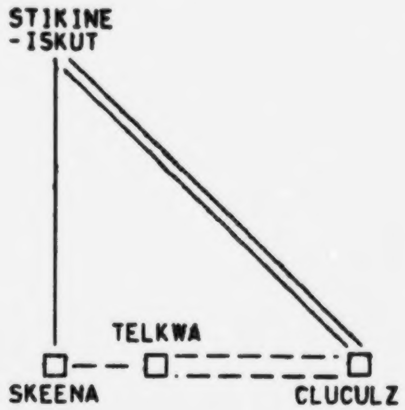
Use of the technically preferred corridors for Scheme 3 would result in 1653 km of transmission line construction at an estimated overall cost of $3,306 million.

Route Engineering Scheme 4 - refer to Figure 6-5 (4)

The technically preferred corridors for this scheme are the same as those for Scheme 2 to the Swan Lake area (pt 21), and are the same as those for Scheme 3 south of pt 21.

Use of these corridors for Scheme 4 would require 1822 km of transmission line construction at an estimated overall cost of $3,791 million.

SYSTEM OPTION III

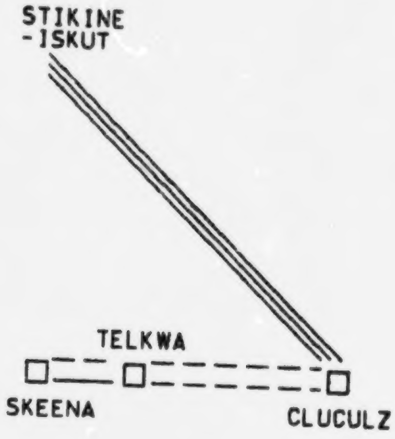


Route Engineering Scheme 5 - refer to Figure 6-5 (5)

This scheme considers interconnection of the Stikine and Iskut transmission circuits at a collector station just south of the Stikine Canyon dam site. The technically preferred corridor to the proposed Cluculz substation follows the B.C. Rail route from pt. 34 to the confluence of the Little Klappan and Klappan rivers, and from pt. 35 at the headwaters of the Klappan, Skeena and Nass rivers to pt. 58 near the Sustut River. The technically preferred corridor to Skeena is the same as for Schemes 1 and 2.

While there are few security hazards along the technically preferred corridor to Cluculz, the extreme length increases the potential for outages and makes use of this corridor unattractive economically.

Use of the technically preferred corridors for Scheme 5 would require 2022 km of transmission line construction at an estimated overall cost of $4,187 million.



SYSTEM OPTION IV

Route Engineering Scheme 6 - refer to Figure 6-5 (6)

The technically preferred corridors for this scheme are similar to those for Scheme 5 except that three circuits carry all the combined Iskut and Stikine power to the proposed Cluculz Substation and there is no direct circuit to Skeena Substation. The technically preferred corridor for the additional 500 kV circuit required to back up the Terrace-Prince Rupert area is the same as that for Schemes 3 and 4.

Use of the technically preferred corridors for Scheme 6 would require 2657 km of transmission line construction at an estimated overall cost of $5,164 million. This is the longest and most expensive of the schemes considered.

Summary

In Schemes 1 through 4 the triangular region south of Bob Quinn Lake and bounded by the Iskut, Ningunsaw and Bell-Irving rivers and the Unuk River and Treaty Creek and is considered to have the lowest overall security in the study area. In particular, the Unuk River-Treaty Creek segment (9 - 10 - 11 - 12 - 13) with high snowfall, avalanche-prone slopes, potential high winds and no access, should be avoided. The good access provided by Highway 37 along the Ningunsaw and Bell-Irving Rivers would facilitate routine and emergency maintenance of the lines.

Schemes 2 and 4 combine the uncertain security of segments 8 - 7 - 5 - 14 - 13 from Iskut Canyon to the Bell-Irving River/Taft Creek confluence with that of the Taft Creek segment (13 - 36) and its potentially unstable soils and possible wind and ice conditions.

There appear to be few major security hazards along the corridors chosen in Schemes 5 and 6, but their extreme length increases the potential for outages and makes these schemes unattractive economically.

Other security hazards exist throughout the study area but are not as significant as those described above. Based upon sound engineering judgement and experience with transmission line construction and maintenance, a system with acceptable security could be installed.

Of the six schemes presented, Scheme 1 would require the least amount of new transmission line construction and the least capital cost as follows:

Scheme	Line Length Difference	Cost Difference
1	(shortest)	(least cost)
2	169 km (11%) more	$474 million (15%) more
3	174 km (12%) more	$247 million (8%) more
4	343 km (23%) more	$732 million (24%) more
5	543 km (37%) more	$1,128 million (37%) more
6	1178 km (80%) more	$2,105 million (69%) more

The lengths and costs of the six schemes are dependent on the corridors selected and will vary from those shown in Table 6-1 if corridors or corridor segments change from those shown on the maps (Figure 6-5 (1-6)). Costs are based on 500 kV construction.

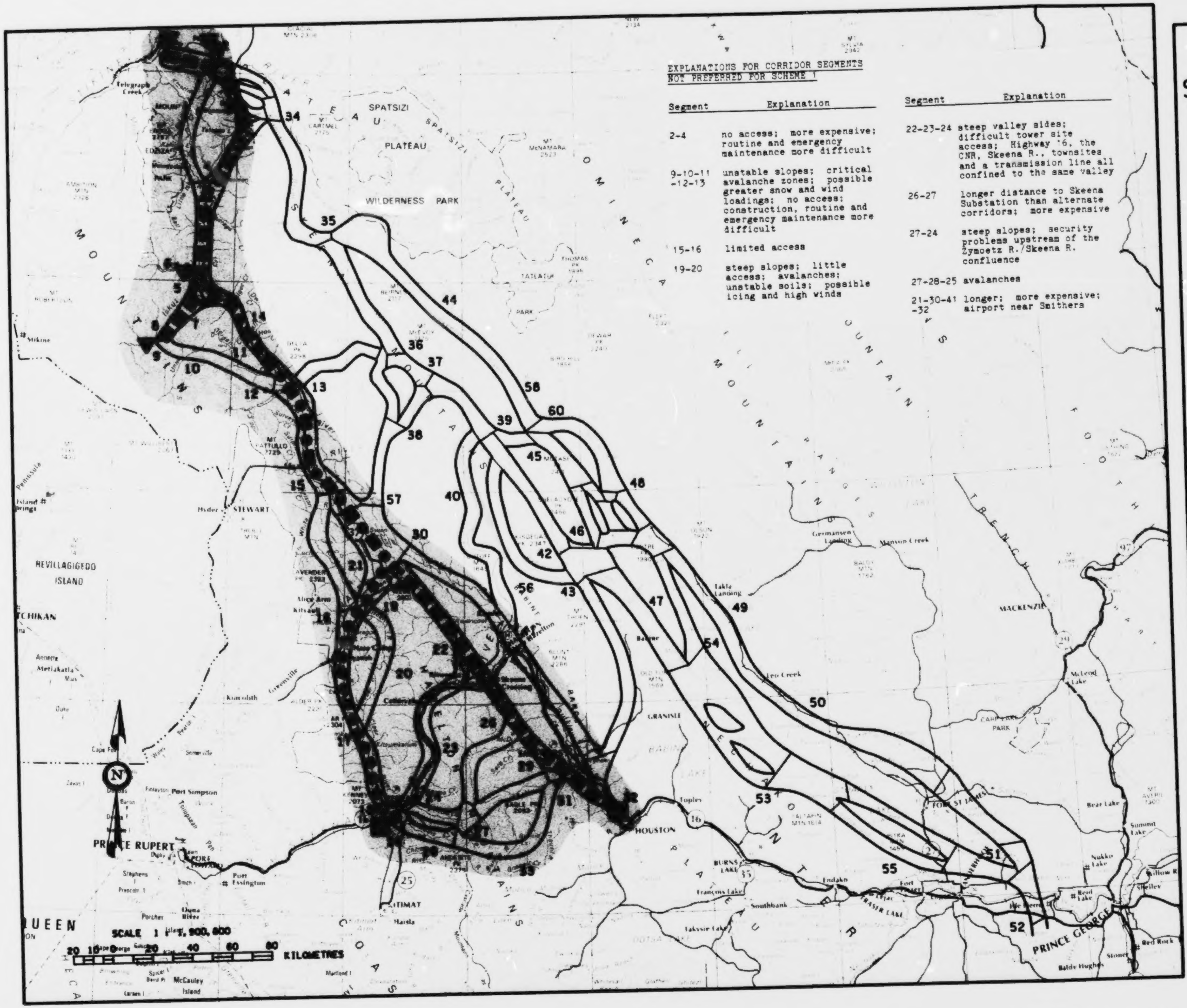
6.3.4 Route Engineering Study Conclusions

From the standpoint of cost, security and maintenance it is recommended that hydroelectric power generated on the Stikine River, Iskut River and More Creek be integrated with the existing B.C. Hydro transmission system with the transmission network outlined in Scheme 1. This preferred technical scheme and the major areas of technical concern are shown in Figure 6-6. This scheme provides for interconnection of the Stikine and Iskut transmission circuits at a collector station in the vicinity of Bob Quinn Lake. Power collected at Bob Quinn from the four generating stations would be transmitted to the existing Telkwa and Skeena substations using two 500 kV transmission circuits to Telkwa and one 500 kV transmission circuit to Skeena. The engineering corridor preference generally follows existing access along the Iskut and Bell-Irving rivers to a point near Meziadin in the Nass River valley. From the Nass the preferred corridor to Telkwa Substation would use the valleys of the Cranberry, Kitwanga and Kitseguecla rivers and remain west of Hudson Bay Mountain. The preferred corridor to Skeena Substation would use the valleys of the Tseax and Kitsumkalum rivers.

FIGURE 6-5 (1)

STIKINE/ISKUT TRANSMISSION STUDIES

TECHNICAL CORRIDOR PREFERENCE SCHEME 1

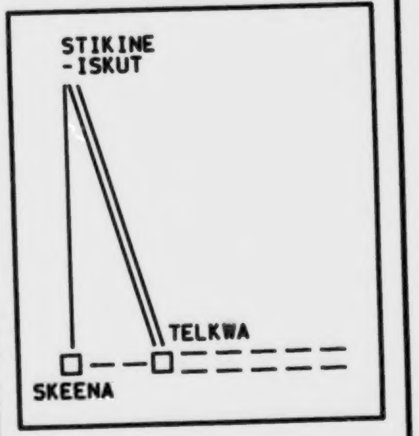


●■● 3 CIRCUITS
■■■ 2 CIRCUITS
●●● 1 CIRCUIT
500 kV
230 kV CIRCUIT
COLLECTOR STATION
SUBSTATION
GENERATING STATION
CORRIDORS CONSIDERED FOR SCHEME 1
SPATSIZI
PLATEAU
WILDERNESS PARK
MOUNTAINS
OMINECA
MOUNTAINS
FRANCOIS
TRENCH
FOOTHILLS
Telegraph Creek
Stikine
STEWART
Hyder
REVILLAGIGEDO ISLAND
KETCHIKAN
Alice Arm
Kitsault
Greenville
Port Simpson
PRINCE RUPERT
Port Essington
KITIMAT
Hazelton
Babine
Takla Landing
Germansen Landing
Manson Creek
MACKENZIE
Leo Creek
GRANISLE
Topley
HOUSTON
BURNS LAKE
Francois Lake
Southbank
Endako
FORT ST JAMES
Fort Fraser
Vanderhoof
Bear Lake
Summit Lake
Nukko Lake
Reid Lake
PRINCE GEORGE
Willow River
Shelley
Red Rock
Stoner
Baldy Hughes
QUEEN
COAST
N
SCALE 1 : 1,900,000
20 10 0 20 40 60 80 KILOMETRES
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 60

EXPLANATIONS FOR CORRIDOR SEGMENTS NOT PREFERRED FOR SCHEME 1

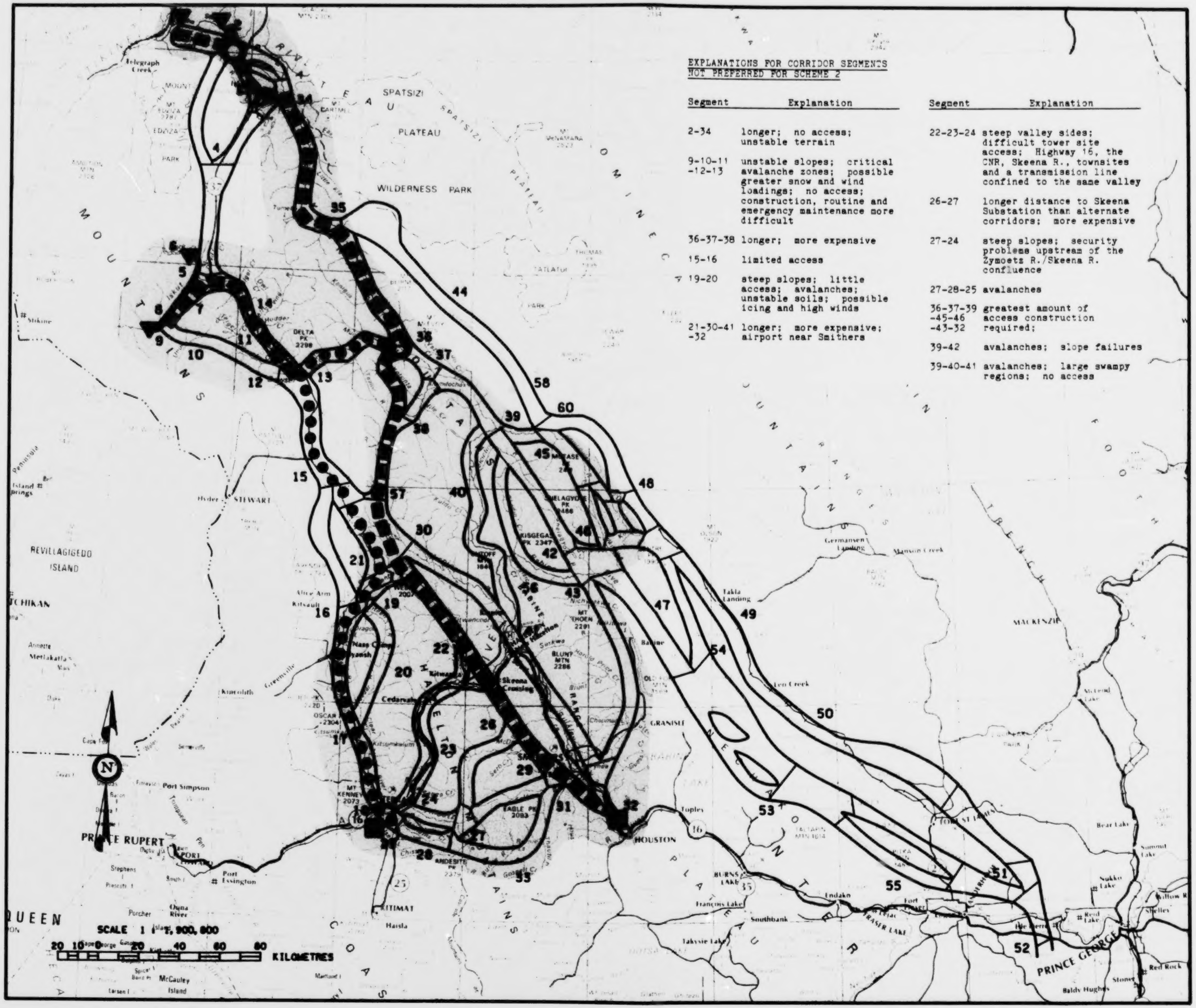
Segment	Explanation
2-4	no access; more expensive; routine and emergency maintenance more difficult
9-10-11 -12-13	unstable slopes; critical avalanche zones; possible greater snow and wind loadings; no access; construction, routine and emergency maintenance more difficult
15-16	limited access
19-20	steep slopes; little access; avalanches; unstable soils; possible icing and high winds
22-23-24	steep valley sides; difficult tower site access; Highway 16, the CNR, Skeena R., townsites and a transmission line all confined to the same valley
26-27	longer distance to Skeena Substation than alternate corridors; more expensive
27-24	steep slopes; security problems upstream of the Zymoetz R./Skeena R. confluence
27-28-25	avalanches
21-30-41 -32	longer; more expensive; airport near Smithers

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.



STIKINE -ISKUT
TELKWA
SKEENA

SYSTEM OPTION I


SPATSIZI
PLATEAU
WILDERNESS PARK
MOUNTAINS
Telegraph Creek
Stikine
STEWART
Hyder
REVILLAGIGEDO ISLAND
PRINCE RUPERT
Port Simpson
Port Essington
KITIMAT
HOUSTON
Burns Lake
Fraser Lake
Takla Landing
Germansen Landing
Manson Creek
MACKENZIE
PRINCE GEORGE
Baldy Hughes
QUEEN
COAST
N
SCALE 1 : 1,900,000
20 10 0 20 40 60 80 KILOMETRES
2
4
5
6
7
8
9
10
11
12
13
14
15
16
17
19
20
21
22
23
24
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EXPLANATIONS FOR CORRIDOR SEGMENTS NOT PREFERRED FOR SCHEME 2

Segment	Explanation
2-34	longer; no access; unstable terrain
9-10-11 -12-13	unstable slopes; critical avalanche zones; possible greater snow and wind loadings; no access; construction, routine and emergency maintenance more difficult
36-37-38	longer; more expensive
15-16	limited access
19-20	steep slopes; little access; avalanches; unstable soils; possible icing and high winds
21-30-41 -32	longer; more expensive; airport near Smithers
22-23-24	steep valley sides; difficult tower site access; Highway 16, the CNR, Skeena R., townsites and a transmission line confined to the same valley
26-27	longer distance to Skeena Substation than alternate corridors; more expensive
27-24	steep slopes; security problems upstream of the Zymoetz R./Skeena R. confluence
27-28-25	avalanches
36-37-39 -45-46 -43-32	greatest amount of access construction required;
39-42	avalanches; slope failures
39-40-41	avalanches; large swampy regions; no access

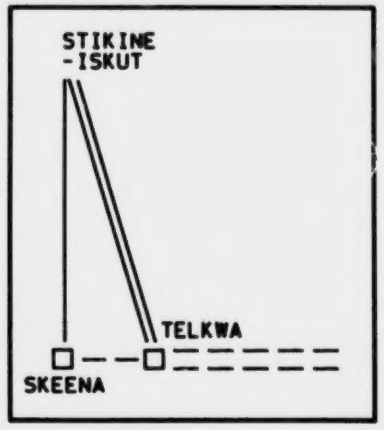
FIGURE 6-5 (2)

STIKINE/ISKUT TRANSMISSION STUDIES

TECHNICAL CORRIDOR PREFERENCE SCHEME 2

■■■	2 CIRCUITS	500 kV
●●●	1 CIRCUIT	500 kV
—	230 kV CIRCUIT	
○	COLLECTOR STATION	
■	SUBSTATION	
▼	GENERATING STATION	
▨	CORRIDORS CONSIDERED FOR SCHEME 2	

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.

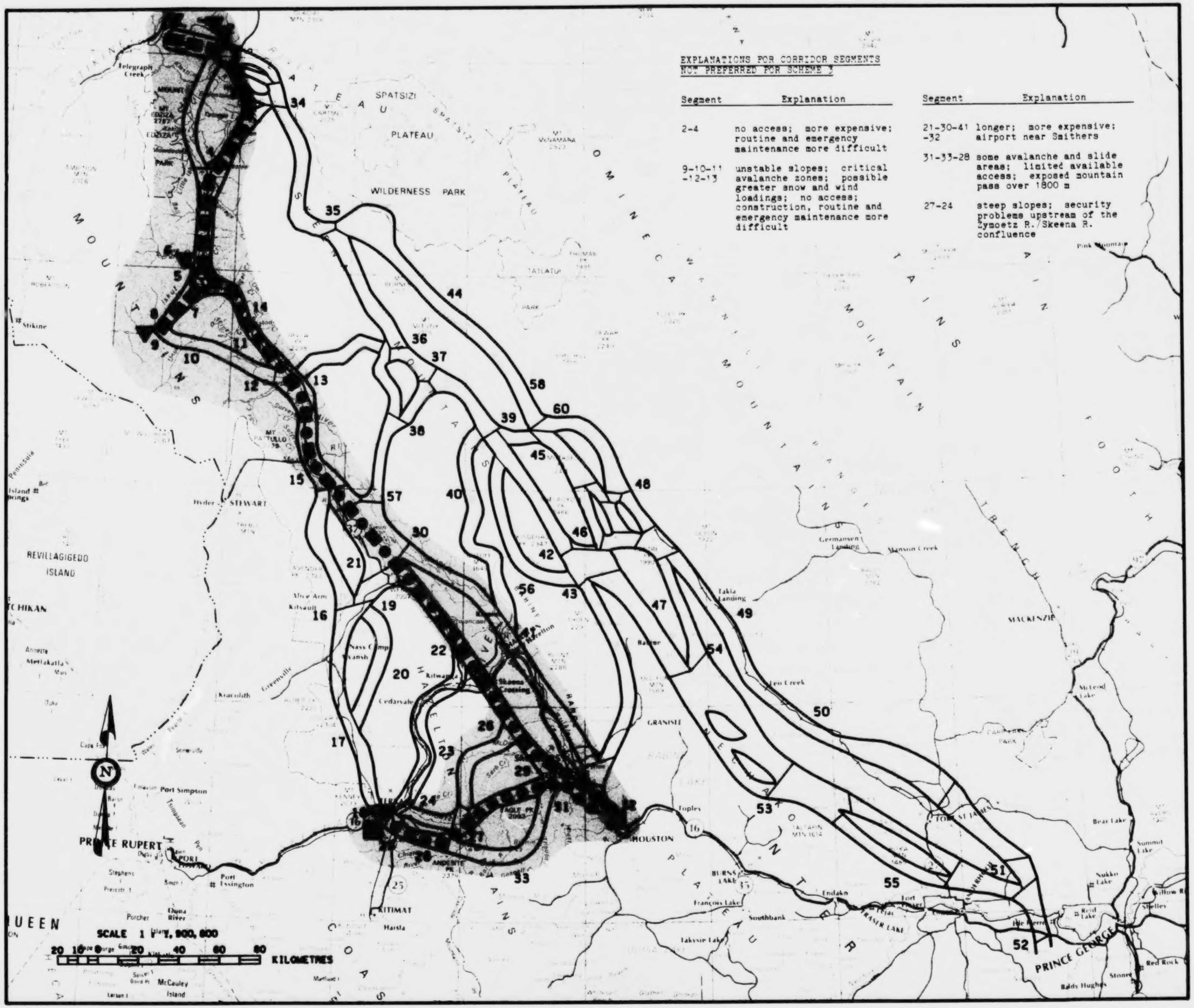

STIKINE
-ISKUT
TELKWA
SKEENA

SYSTEM OPTION I

FIGURE 6-5 (3)

STIKINE/ISKUT TRANSMISSION STUDIES

TECHNICAL CORRIDOR PREFERENCE SCHEME 3



STIKINE
Telegraph Creek
MOUNT EDZIZA
PARK
PLATEAU
SPATSIZI
WILDERNESS PARK
OMINECA MOUNTAINS
MOUNTAINS
Stikine
STEWART
Hyder
REVILLAGIGEDO ISLAND
KETCHIKAN
Alice Arm
Kitsault
Nass Camp
Aiyansh
Kitwanga
Cedarvale
Greenville
Kincolith
Port Simpson
PRINCE RUPERT
Port Essington
KITIMAT
Kitimat
Haisla
HOUSTON
Topley
BURNS LAKE
Francois Lake
Southbank
Endako
Fort Fraser
FRASER LAKE
Fort St. James
Vanderhoof
PRINCE GEORGE
Germansen Landing
Manson Creek
Takla Landing
Babine
GRANISLE
Fort St. James
MACKENZIE
McLeod Lake
Bear Lake
Summit Lake
Pink Mountain
HAZELTON
COAST
HANSON
NECHAKO PLATEAU
TRENCH
Takysie Lake
Baldy Hughes
Stoner
Red Rock
Porcher
Stephens
QUEEN
SCALE 1 : 1,900,000
20 10 0 20 40 60 80 KILOMETRES
N
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 60

EXPLANATIONS FOR CORRIDOR SEGMENTS NOT PREFERRED FOR SCHEME 3

Segment	Explanation
2-4	no access; more expensive; routine and emergency maintenance more difficult
9-10-11-12-13	unstable slopes; critical avalanche zones; possible greater snow and wind loadings; no access; construction, routine and emergency maintenance more difficult
21-30-41-32	longer; more expensive; airport near Smithers
31-33-28	some avalanche and slide areas; limited available access; exposed mountain pass over 1800 m
27-24	steep slopes; security problems upstream of the Zymoetz R./Skeena R. confluence

●■● 3 CIRCUITS
■■■ 2 CIRCUITS
●●● 1 CIRCUIT
} 500 kV

— 230 kV CIRCUIT

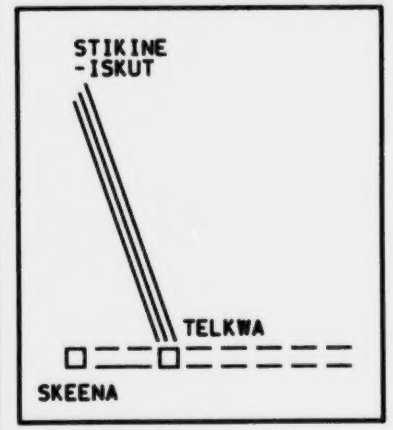
○ COLLECTOR STATION

■ SUBSTATION

▼ GENERATING STATION

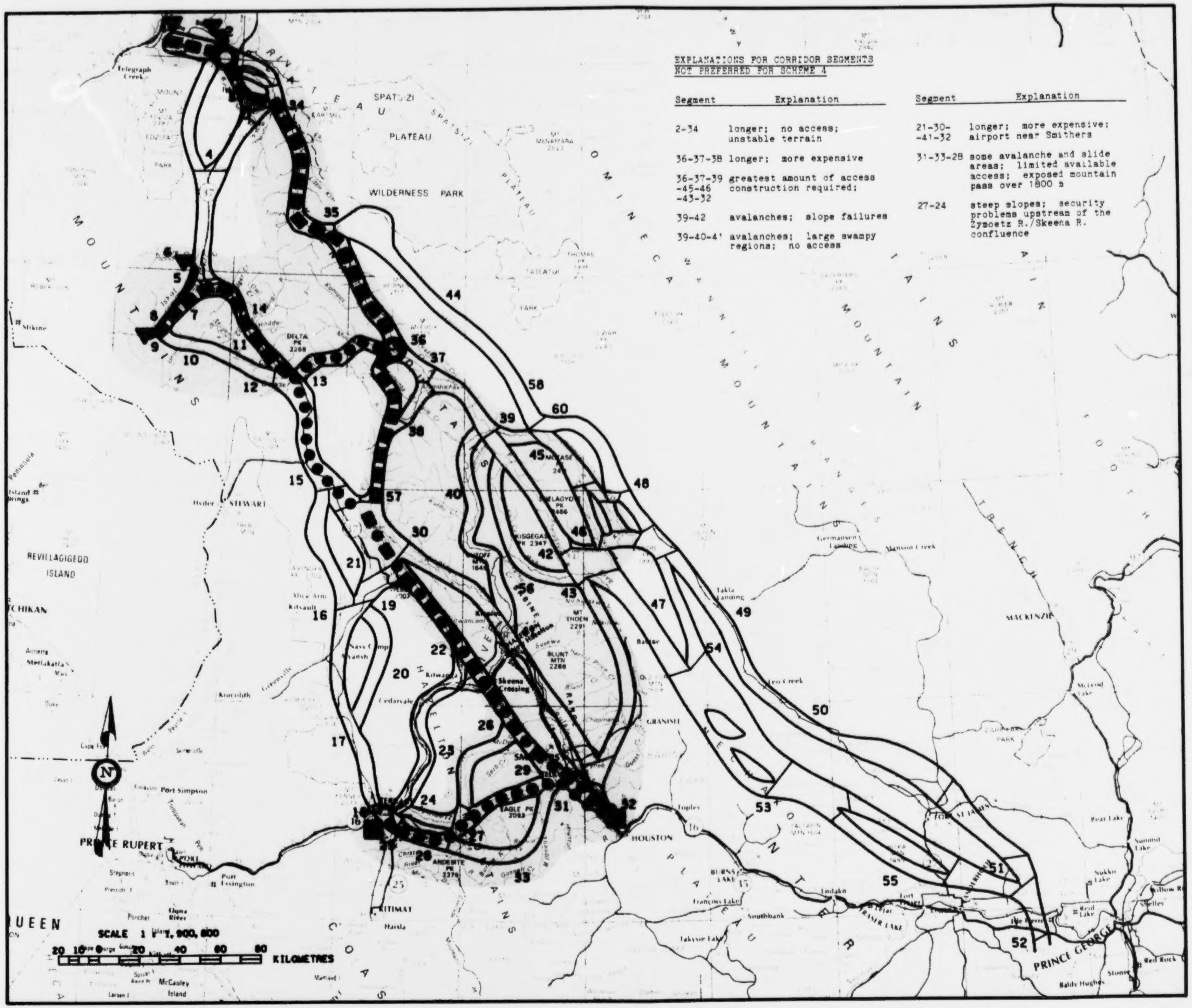
CORRIDORS CONSIDERED FOR SCHEME 3

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.



STIKINE -ISKUT
TELKWA
SKEENA

SYSTEM OPTION II


Telegraph Creek
SPATSIZI
PLATEAU
WILDERNESS PARK
MOUNTAINS
STIKINE
OMINECA MOUNTAINS
SKEENA MOUNTAINS
ROCKY MOUNTAIN TRENCH
NECHAKO PLATEAU
HAZELTON MOUNTAINS
COAST MOUNTAINS
DELTA PK 2288
MT THOEN 2291
BLUNT MTN 2286
KISGEGAS PK 2347
EAGLE PK 2083
ANDESITE PK 2370
Skeena Crossing
Kitwanga
Cedarvale
STEWART
Hyder
Alice Arm
Kitsault
REVILLAGIGEDO ISLAND
KETCHIKAN
Annette
Metlakatla
Port Simpson
PRINCE RUPERT
Port Essington
KITIMAT
Haisla
HOUSTON
Topley
BURNS LAKE
Francois Lake
Southbank
Takysie Lake
Endako
Fort Fraser
FRASER LAKE
Vanderhoof
PRINCE GEORGE
Germansen Landing
Manson Creek
Takla Landing
MACKENZIE
McLeod Lake
Bear Lake
Summit Lake
Reid Lake
Isle Pierre
Stoner
Baldy Hughes
Red Rock
GRANISLE
Fort St James
Babine
McCauley Island
QUEEN
Porcher
Oona River
Stephens
Cape Fox
Duke
Kincolith
Greenville
1
2
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6
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SCALE 1 : 1,900,000
20 10 0 20 40 60 80 KILOMETRES

EXPLANATIONS FOR CORRIDOR SEGMENTS NOT PREFERRED FOR SCHEME 4

Segment	Explanation
2-34	longer; no access; unstable terrain
36-37-38	longer; more expensive
36-37-39 -45-46 -43-32	greatest amount of access construction required;
39-42	avalanches; slope failures
39-40-41	avalanches; large swampy regions; no access

Segment	Explanation
21-30- -41-32	longer; more expensive: airport near Smithers
31-33-28	some avalanche and slide areas; limited available access; exposed mountain pass over 1800 m
27-24	steep slopes; security problems upstream of the Zymoetz R./Skeena R. confluence

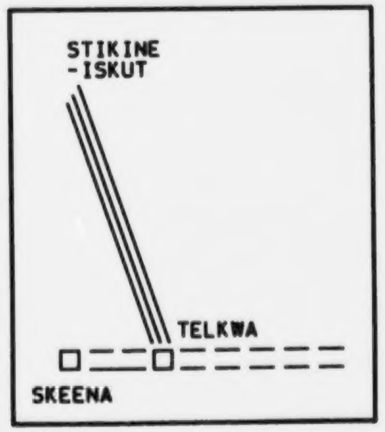
FIGURE 6-5 (4)

STIKINE/ISKUT TRANSMISSION STUDIES

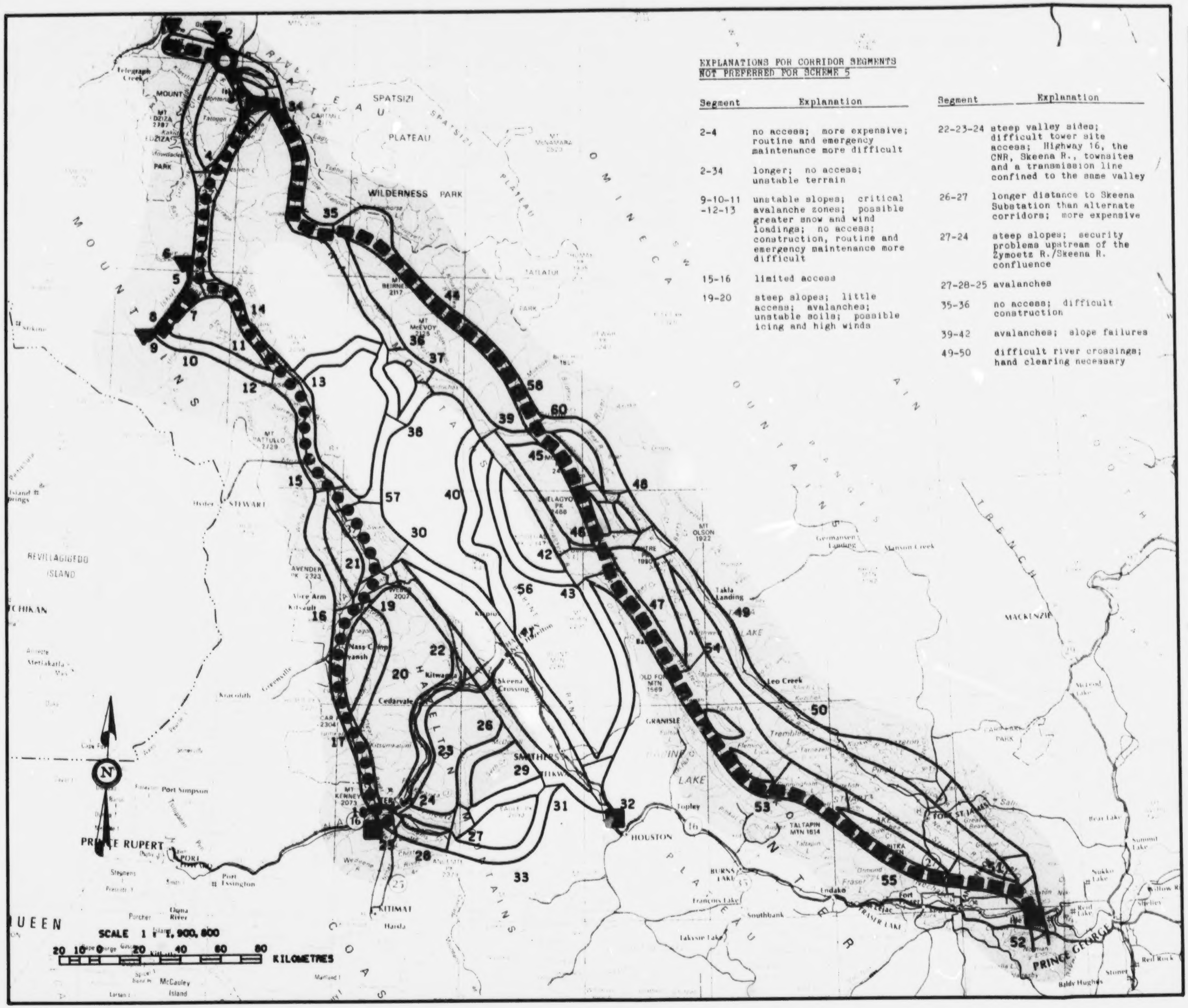
TECHNICAL CORRIDOR PREFERENCE SCHEME 4

●■●	3 CIRCUITS	500 kV
■■■	2 CIRCUITS	
●●●	1 CIRCUIT	
━━	230 kV CIRCUIT	
○	COLLECTOR STATION	
■	SUBSTATION	
▼	GENERATING STATION	
	CORRIDORS CONSIDERED FOR SCHEME 4	

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.


STIKINE -ISKUT
TELKWA
SKEENA

SYSTEM OPTION II


SPATSIZI PLATEAU
WILDERNESS PARK
OMINECA MOUNTAINS
SKEENA MOUNTAINS
HAZELTON MOUNTAINS
COAST MOUNTAINS
NECHAKO PLATEAU
ROCKY MOUNTAIN TRENCH
Telegraph Creek
MOUNT DZIZA 2787
MT PATTULLO 2729
STEWART
REVILLAGIGEDO ISLAND
Alice Arm
Kitsault
Nass Camp
Aiyansh
Kitwanga
Cedarvale
Skeena Crossing
SMITHERS
TELKWA
HOUSTON
Topley
BURNS LAKE
Fraser Lake
Fort St. James
Takla Landing
Germansen Landing
Manson Creek
Leo Creek
GRANISLE
MACKENZIE
PRINCE RUPERT
Port Simpson
Port Essington
KITIMAT
Hartley Bay
TERRACE
PRINCE GEORGE
Vanderhoof
Baldy Hughes
Stoner
Summit Lake
McCauley Island
SCALE 1 : 1,900,800
20 10 0 20 40 60 80 KILOMETRES
N
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EXPLANATIONS FOR CORRIDOR SEGMENTS NOT PREFERRED FOR SCHEME 5

Segment	Explanation
2-4	no access; more expensive; routine and emergency maintenance more difficult
2-34	longer; no access; unstable terrain
9-10-11 -12-13	unstable slopes; critical avalanche zones; possible greater snow and wind loadings; no access; construction, routine and emergency maintenance more difficult
15-16	limited access
19-20	steep slopes; little access; avalanches; unstable soils; possible icing and high winds
22-23-24	steep valley sides; difficult tower site access; Highway 16, the CNR, Skeena R., townsites and a transmission line confined to the same valley
26-27	longer distance to Skeena Substation than alternate corridors; more expensive
27-24	steep slopes; security problems upstream of the Zymoetz R./Skeena R. confluence
27-28-25	avalanches
35-36	no access; difficult construction
39-42	avalanches; slope failures
49-50	difficult river crossings; hand clearing necessary

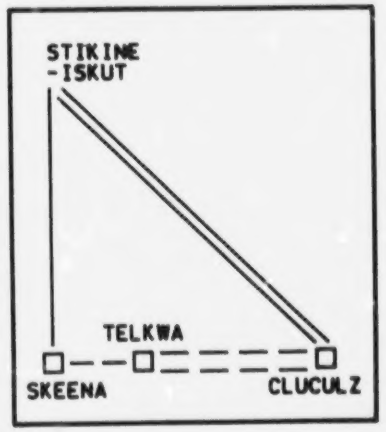
FIGURE 6-5 (5)

STIKINE/ISKUT TRANSMISSION STUDIES

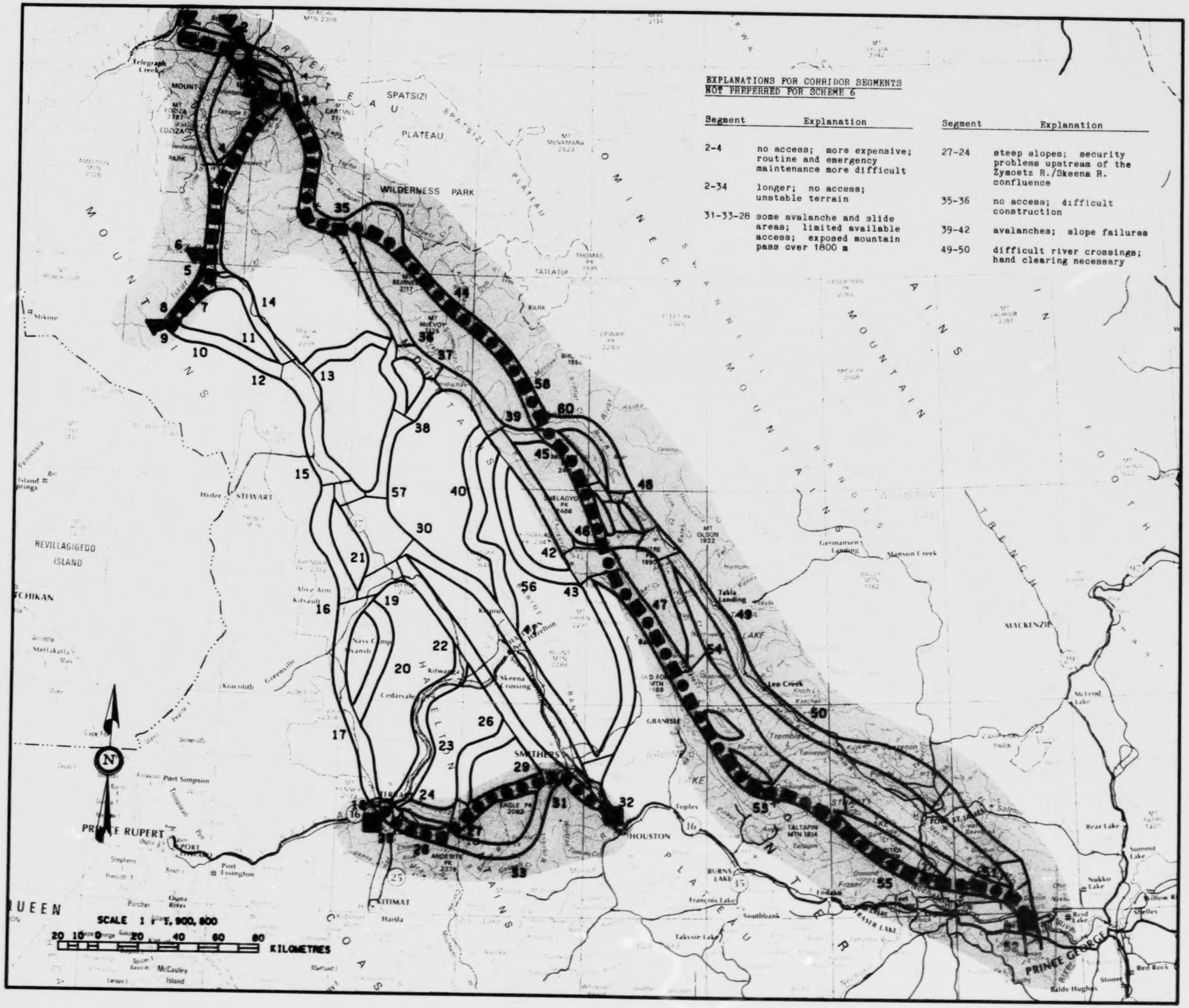
TECHNICAL CORRIDOR PREFERENCE SCHEME 5

●■● 3 CIRCUITS }
■■■ 2 CIRCUITS } 500 kV
●●● 1 CIRCUIT }
— 230 kV CIRCUIT
○ COLLECTOR STATION
■ SUBSTATION
▼ GENERATING STATION
CORRIDORS CONSIDERED FOR SCHEME 5

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.


STIKINE -ISKUT
TELKWA
SKEENA
CLUCULZ

SYSTEM OPTION III


STIKINE
Telegraph Creek
MOUNT EDZIZA
EDZIZA PARK
SPATSIZI PLATEAU
WILDERNESS PARK
SPATSIZI PLATEAU
OMINECA MOUNTAINS
SWANNELL RANGES
MOUNTAINS
TATLATUI PARK
Stikine
Hyder
STEWART
REVILLAGIGEDO ISLAND
KETCHIKAN
Alice Arm
Kitsault
Nass Camp
Aiyansh
Kitwanga
Cedarvale
Hazelton
Skeena Crossing
SMITHERS
TERRACE
HOUSTON
KITIMAT
PRINCE RUPERT
Port Simpson
Port Essington
Topley
BURNS LAKE
FRASER LAKE
Endako
GRANISLE
BABINE LAKE
Germansen Landing
Manson Creek
Tatla Landing
Leo Creek
MACKENZIE
PRINCE GEORGE
Stoner
Red Rock
Baldy Hughes
TALTAPIN MTN 1814
EAGLE PK 2083
ANDESITE PK 2378
QUEEN
N
1 2 4 5 6 7 8 9 10 11 12 13 14 15 16 17 19 20 21 22 23 24 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 42 43 44 45 46 47 48 49 50 52 53 54 55 56 57 58 60
SCALE 1 : 1,900,800
20 10 0 20 40 60 80
KILOMETRES

EXPLANATIONS FOR CORRIDOR SEGMENTS NOT PREFERRED FOR SCHEME 6

Segment	Explanation
2-4	no access; more expensive; routine and emergency maintenance more difficult
2-34	longer; no access; unstable terrain
31-33-28	some avalanche and slide areas; limited available access; exposed mountain pass over 1800 m
27-24	steep slopes; security problems upstream of the Zymoetz R./Skeena R. confluence
35-36	no access; difficult construction
39-42	avalanches; slope failures
49-50	difficult river crossings; hand clearing necessary

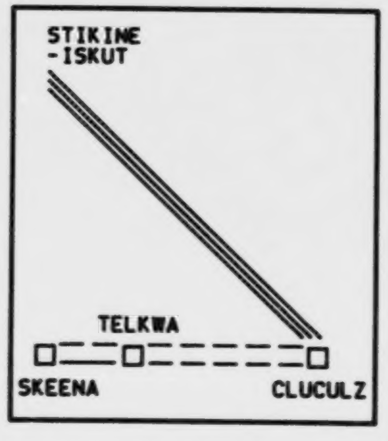
FIGURE 6-5 (6)

STIKINE/ISKUT TRANSMISSION STUDIES

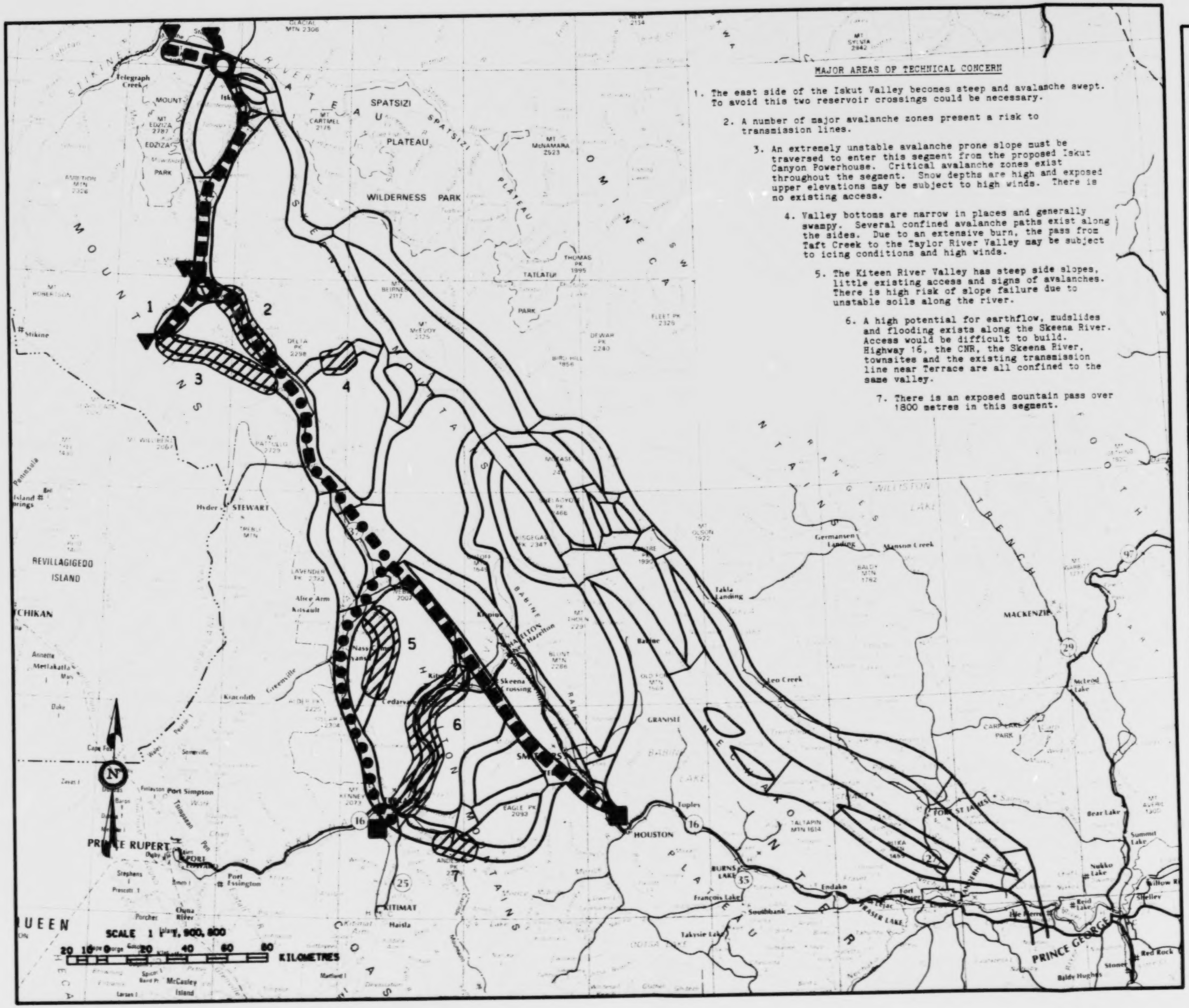
TECHNICAL CORRIDOR PREFERENCE SCHEME 6

●■● 3 CIRCUITS } 500 kV
■■■ 2 CIRCUITS } 500 kV
●●● 1 CIRCUIT } 500 kV
── 230 kV CIRCUIT
○ COLLECTOR STATION
■ SUBSTATION
▼ GENERATING STATION
CORRIDORS CONSIDERED FOR SCHEME 6

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.


STIKINE -ISKUT
TELKWA
SKEENA
CLUCULZ

SYSTEM OPTION IV


STIKINE
Telegraph Creek
MOUNT EDZIZA PARK
SPATSIZI PLATEAU WILDERNESS PARK
TATLATUI PARK
OMINECA
MOUNTAINS
SKEENA
HAZELTON
MOUNTAINS
NECHAKO PLATEAU
STEWART
Hyder
REVILLAGIGEDO ISLAND
KETCHIKAN
Alice Arm
Kitsault
Cedarvale
Skeena Crossing
Babine
Takla Landing
Germansen Landing
Manson Creek
WILLISTON LAKE
MACKENZIE
ROCKY MOUNTAIN TRENCH
SMITHERS
HOUSTON
Topley
BURNS LAKE
FORT ST JAMES
Vanderhoof
PRINCE GEORGE
PRINCE RUPERT
Port Simpson
Port Essington
KITIMAT
1
2
3
4
5
6
7
SCALE 1 : 1,900,000
20 10 0 20 40 60 80
KILOMETRES

MAJOR AREAS OF TECHNICAL CONCERN

1. The east side of the Iskut Valley becomes steep and avalanche swept. To avoid this two reservoir crossings could be necessary.
2. A number of major avalanche zones present a risk to transmission lines.
3. An extremely unstable avalanche prone slope must be traversed to enter this segment from the proposed Iskut Canyon Powerhouse. Critical avalanche zones exist throughout the segment. Snow depths are high and exposed upper elevations may be subject to high winds. There is no existing access.
4. Valley bottoms are narrow in places and generally swampy. Several confined avalanche paths exist along the sides. Due to an extensive burn, the pass from Taft Creek to the Taylor River Valley may be subject to icing conditions and high winds.
5. The Kiteen River Valley has steep side slopes, little existing access and signs of avalanches. There is high risk of slope failure due to unstable soils along the river.
6. A high potential for earthflow, mudslides and flooding exists along the Skeena River. Access would be difficult to build. Highway 16, the CNR, the Skeena River, townsites and the existing transmission line near Terrace are all confined to the same valley.
7. There is an exposed mountain pass over 1800 metres in this segment.

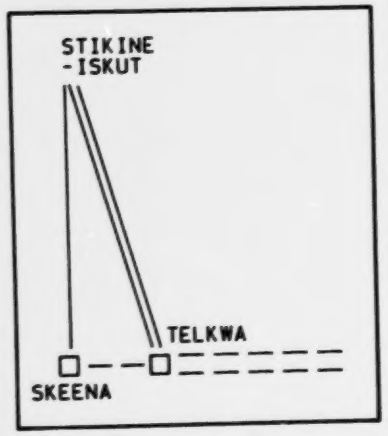
FIGURE 6-6

STIKINE/ISKUT TRANSMISSION STUDIES

MAJOR AREAS OF TECHNICAL CONCERN AND PREFERRED TECHNICAL SCHEME (1)

●■● 3 CIRCUITS } 500 kV
■■■ 2 CIRCUITS } 500 kV
●●● 1 CIRCUIT } 500 kV
— 230 kV CIRCUIT
○ COLLECTOR STATION
■ SUBSTATION
▼ GENERATING STATION
▨ MAJOR AREAS OF TECHNICAL CONCERN

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.


STIKINE
-ISKUT
TELKWA
SKEENA

SYSTEM OPTION I

6.4 Determination of Corridors for Further Study

In the preliminary corridor assessment studies, the environmental consultants and B.C. Hydro route engineers identified preferred corridors which would meet electric system requirements. Implicit in this selection of corridors are preferred destinations.

In the discussion that follows, B.C. Hydro's rationale for recommending particular destinations and corridors for further consideration is described. In some instances the environmental consultants and route engineers concur in their corridor preferences. Where there is not agreement, the individual concerns are brought forward, considered, and a recommendation is made. These considerations are made in the context of three factors: economic, environmental and technical, which provide an account of the practical difficulties or advantages of a particular corridor.

No final decision on the choice of corridors for detailed study will be made until government and public consultation is carried out and information obtained during this process is considered.

6.4.1 Transmission Line Destinations

Initial studies of corridors considered three destinations from the Stikine-Iskut generation sites: namely Skeena, Telkwa and Cluculz (See Figure 3-3).

Further definition of electric system requirements subsequent to these studies have determined that direct transmission line links between the Stikine-Iskut generation sites and Cluculz are neither required nor desirable. Costs would be considerably higher than alternative system connections to the Skeena and Telkwa substations (see Table 6-1, Summary of route engineering scheme costs), and the length of the lines would result in a greater potential for outages and system instability. In addition to these economic and technical factors the corridor assessments indicate that the Cluculz destination would be the least desirable on environmental grounds (see Section 6.2.3 - Summary). Consequently, B.C. Hydro is no longer considering Cluculz as a direct destination for Stikine-Iskut transmission lines.

Elimination of the Cluculz terminus means that Stikine-Iskut transmission would connect to the provincial grid at Skeena and/or Telkwa (See Figure 4-1). Whether one transmission line goes directly to Skeena or whether an additional line would go between Telkwa and Skeena depends on factors such as load growth in the area and has not yet been resolved. Recognizing this, no attempt is made here to indicate a system option preference, but merely to indicate, with reasons, those corridors between the generation sites and Skeena and Telkwa that are preferred and recommended for further study.

6.4.2 Corridors

The corridor recommended as the most favoured on environmental grounds is that designated in Alternative D (See Figure 6-3D). This alternative had the same number of high and severe impacts as Alternative F (See Figure 6-3F), but was ranked best overall because it is shorter in corridor length and requires less new access.

Alternative D (See Figures 6-3D and 6-7) has the Stikine-Iskut collector station at the confluence of Muckaboo Creek and the Nass River with the corridor from the Stikine generating sites following the Klappan and Nass River valleys and the corridor from Iskut Canyon/More Creek going via the Iskut River, Unuk River-Treaty Creek and Taft River segments to the Muckaboo collector. From there the corridor goes down the Taylor River valley, past Swan Lake and Kitwanga Lake and across the Skeena River to Telkwa Substation via the west side of Hudson's Bay Mountain. The link to Skeena branches off the Kitwanga Lake segment and follows the Zymoetz River valley.

The corridor preferred by B.C. Hydro route engineers (See Figures 6-5(1) and 6-7) generally follows Highway 37 from the Stikine generation sites past More Creek to the Bob Quinn Lake area, where the Stikine-Iskut collector station would be located. The corridor preferred from Iskut Canyon follows the Iskut valley to the collector. From there the corridor continues to follow Highway 37 to the Swan Lake area where one corridor goes via Kitwanga Lake, the Skeena River and Hudson's Bay Mountain to the Telkwa Substation and the other follows the Cranberry River, Lava Lake and Kitsumkalem River valleys to Skeena Substation.

Examination of the individual corridor preferences shows that they are identical only in the short segment at Swan Lake. This area can therefore be considered a node or common point. The corridors between the generation sites and Swan Lake and those between Swan Lake and the Telkwa and Skeena substations will be considered separately in the following examination of corridor preferences.

Generation Sites to Swan Lake

The environmental and technical corridor preferences north of Swan Lake together with associated environmental impact scores, technical line construction cost estimates and a summary of route engineering and environmental considerations are shown in Table 6-2. Environmental data are presented in Table 6-3 on a segment-specific basis for environmental comparison of the individual corridor preferences.

The environmental analysis indicated a greater number of high and severe impacts along the Highway 37 corridor than along the Klappan, Nass, Unuk River-Treaty Creek and Taft Creek corridors. The types of potential impacts also differ. Along the Highway 37 corridor, recreation and scenic resources are of concern while along the environmentally preferred corridor, the impact on wildlife is the major concern.

Transmission lines would be more expensive to construct along the environmentally preferred corridor. The difference is substantial amounting to approximately $100 million in direct transmission costs compared with the route engineering preference, or twenty-five per cent more expensive.

Constructing transmission lines along the environmentally preferred corridor would result in a large amount of new access being developed into what is at present essentially undisturbed country, creating the potential for increased hunting pressure on wildlife. The transmission lines and rights-of-way would need to be maintained and it would be most difficult to restrict access after construction was complete, hence the impact on wildlife could not readily be mitigated.

Maintenance and reliability of service of transmission lines along the environmentally preferred corridor would be most difficult to achieve particularly when the harsh winters and rugged terrain of the area are considered. On the other hand, transmission lines located in the proximity of Highway 37 would be much more easily serviced, resulting in a more reliable transmission system.

The potential impacts on scenic and recreation resources along the Highway 37 corridor (technical preference) could be more readily mitigated than the wildlife impacts along the Klappan and Nass corridors. For example, by careful routing of the transmission line, it should be possible to restrict the visibility of the line along large portions of Highway 37.

Having weighed the advantages and disadvantages of the alternative corridors, it is recommended that the Highway 37 corridor be retained for further detailed study. The primary reasons for this recommendation are as follows:

- a direct cost difference of approximately $100 million or 25 per cent in favour of the Highway 37 corridor;
- the security of the transmission lines and accessibility for routine and emergency servicing would be significantly better;
- the creation of new access into areas with high wilderness values would be avoided;
- potential impacts along Highway 37 could be largely mitigated by careful routing of the transmission line within the corridor.

Swan Lake to Skeena and Telkwa

The environmental and technical corridor preferences to Skeena and Telkwa, together with associated environmental impact scores, transmission line construction cost estimates, route engineering and environmental considerations, are shown in Table 6-4. Environmental data are presented in Table 6-5 on a segment-specific basis for environmental comparison of the corridors.

The corridor to Telkwa via Kitwanga Lake and Hudson's Bay Mountain is common to both the technical and environmental corridor preferences, but the corridor preferences to Skeena Substation are substantially different (See Figure 6-7 and Table 6-4). The technical corridor preference follows the Cranberry River, Lava Lake and Kitsumkalem River valleys to Skeena Substation. The environmental corridor preference branches off the Kitwanga Lake corridor and follows the Zymoetz River valley to Skeena.

There would be a greater potential for high and severe impacts using the Lava Lake alternative to Skeena than using the Zymoetz River valley. Recreation, forestry, heritage and terrain are the major concerns in the Lava Lake segment while forestry and terrain are concerns along the Zymoetz River valley. In the Kitwanga Lake corridor segment, which is common to both preferences, there is potential for high and severe impacts on forestry. In addition, there are socio-economic concerns in the vicinity of Skeena Crossing. The cumulative environmental impacts of routing three transmission lines down the Kitwanga Lake corridor as suggested by the consultants versus routing two as suggested by the route engineers could not be determined at this preliminary level of study. For this reason the numerical totals of high and severe impacts in the above comparison should be considered indicative but not absolute.

The types of potential environmental impacts for both corridor preferences are quite similar. Both would include forestry, terrain and socio-economic impacts.

The direct cost of transmission for the environmental preference would be approximately $17 million or nine percent more than for the technical preference. This is due to the fact that while the corridor length for the environmental preference is shorter, the actual length of transmission lines required would be greater.

It should be noted that Highway 16, the Canadian National Railway, a gas pipeline and an existing 500 kV line are all confined to the Skeena River valley just northeast of Terrace. Hence it would be difficult, though not impossible, to locate an additional line there.

Access would have to be constructed into the upper part of the Zymoetz River segment if the environmental corridor preference were used.

Examination of the Lava Lake corridor taking into account the types of potential impacts suggests that the impacts could be largely mitigated by careful routing of the transmission line within the corridor.

Evaluation of the advantages and disadvantages of the two alternatives is not conclusive at this stage of study. The environmental corridor preference presents some technical concerns while the reverse is true for the technical corridor preference. It is therefore recommended that both preferences be retained for further study.

Telkwa to Skeena

As discussed earlier in this section, it is not yet resolved from a system standpoint whether Skeena Substation would be served directly from the Stikine-Iskut or via an additional line between Telkwa and Skeena installed at a later, as yet undetermined date. Therefore, it is proposed that the latter option also be retained at this time, and that further study of a preferred corridor between Telkwa and Skeena be carried out. The rationale for recommending a preferred corridor is presented below.

The environmental corridor preference between Telkwa and Skeena goes south of the existing transmission line via the Burnie and Clore River valleys and along the Williams Creek valley to Skeena (See Figure 6-3F).

The technical corridor preference follows the existing transmission line along the Limonite Creek segment to the Trapline Creek segment where it branches off and follows Williams Creek to Skeena.

It should be noted that in combination with the Limonite Creek segment, the consultants prefer the Thornhill Mountain segment which follows Zymoetz River and the existing transmission lines. The latter segment has already been recommended for further study.

The Williams Creek and Mount Herman corridor segments to Skeena are recommended for further study in consideration of the congestion in the Skeena River valley northeast of Terrace noted in Table 6-4.

The corridor preferences between the Williams Creek segment and Telkwa differ (See Figure 6-8). Table 6-6 summarizes environmental impact scores, transmission line construction cost estimates and route engineering and environmental considerations. Specific environmental data is presented in Table 6-7.

The technical preference would have a greater number of high and severe impacts than the environmental corridor preference. The types of potential environmental impacts for both are similar and emphasize terrain concerns.

Access in the Burnie River segment is limited, whereas in the Limonite-Trapline Creek segments, access associated with the existing transmission line could be used.

There is a high mountain pass over 1800 m and the potential for severe wind and icing conditions in the Burnie River segment.

The environmental corridor preference would require approximately 10 km more transmission line construction at a direct cost of $14 million or twenty-seven per cent more than for the technical corridor preference.

It is recommended that the corridor the existing transmission line follows (Limonite Creek - Trapline Creek) be retained for further study for the following reasons:

- it is less expensive by approximately $14 million or twenty-seven per cent;
- access associated with the existing transmission line could be utilized, thereby avoiding the creation of access in the Burnie River corridor segment;
- high elevations and potential icing and severe winds in the Burnie River segment would be avoided;
- the potential environmental impacts could be mitigated by careful transmission line routing and construction.

Summary

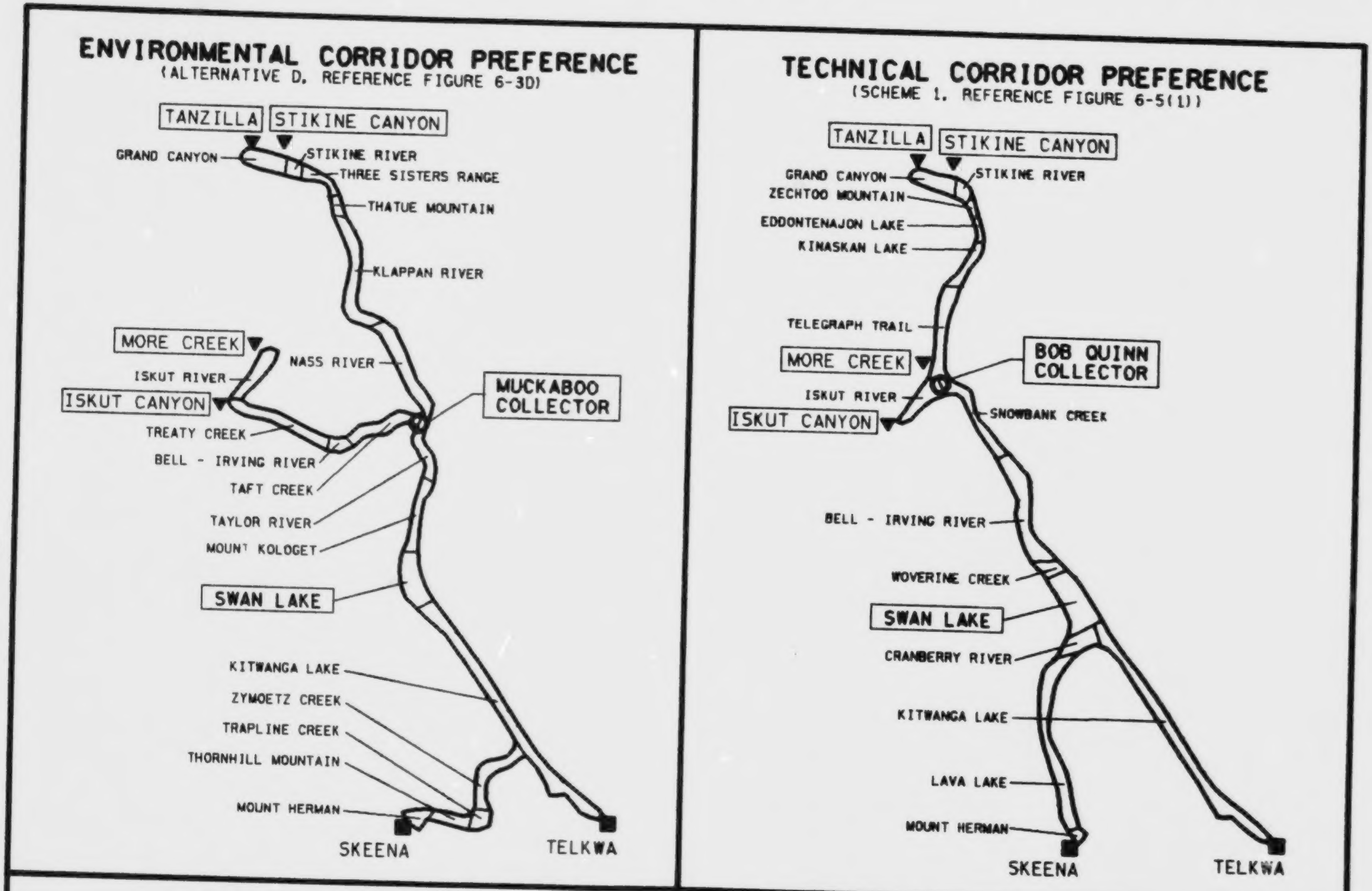
Cluculz has been ruled out as a direct destination for Stikine-Iskut transmission lines because of associated high costs, security and system stability concerns, and high environmental impacts. Transmission lines from the Stikine-Iskut generation sites would therefore connect to the existing transmission grid at Skeena and/or Telkwa substations.

The Highway 37 corridor between the generation sites and Swan Lake is recommended for further study. Use of this corridor for transmission lines versus the alternate corridors down the Klappan and Nass rivers would be significantly less expensive and security and accessibility of the lines would be better. Careful routing of the transmission lines could largely mitigate potential impacts on scenic and recreation resources down Highway 37 whereas potential impacts on wildlife due to creation of access into the Nass and Klappan river areas would be difficult to mitigate.

South of Swan Lake, the corridor via Kitwanga Lake, the Skeena River and west of Hudson's Bay Mountain to Telkwa Substation is recommended for further study. This corridor is a common environmental and technical preference.

The corridor following the Cranberry River, Lava Lake and the Kitsumkalem River valleys to Skeena Substation and the corridor following the Zymoetz River valley to Skeena are recommended for further study. This considers both environmental and technical preferences.

Between Telkwa and Skeena the corridor along the existing 500 kV line and the corridor along Williams Creek are recommended for further study. The Williams Creek corridor is a means of avoiding the congestion in the Skeena River valley just northeast of Terrace.



ENVIRONMENTAL CORRIDOR PREFERENCE
(ALTERNATIVE D, REFERENCE FIGURE 6-3D)

TANZILLA
STIKINE CANYON
GRAND CANYON
STIKINE RIVER
THREE SISTERS RANGE
THATUE MOUNTAIN
KLAPPAN RIVER
MORE CREEK
NASS RIVER
ISKUT RIVER
ISKUT CANYON
MUCKABOO COLLECTOR
TREATY CREEK
BELL - IRVING RIVER
TAFT CREEK
TAYLOR RIVER
MOUNT KOLOGET
SWAN LAKE
KITWANGA LAKE
ZYMOETZ CREEK
TRAPLINE CREEK
THORNHILL MOUNTAIN
MOUNT HERMAN
SKEENA
TELKWA

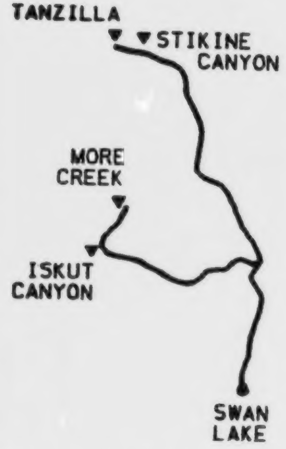
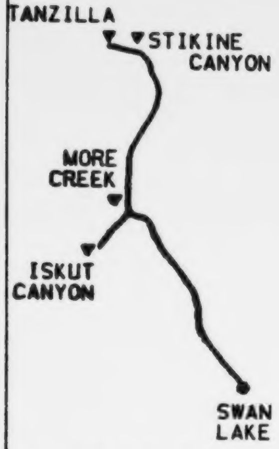
TECHNICAL CORRIDOR PREFERENCE
(SCHEME 1, REFERENCE FIGURE 6-5(1))

TANZILLA
STIKINE CANYON
GRAND CANYON
STIKINE RIVER
ZECHTOO MOUNTAIN
EDDONTENAJON LAKE
KINASKAN LAKE
TELEGRAPH TRAIL
MORE CREEK
BOB QUINN COLLECTOR
ISKUT RIVER
ISKUT CANYON
SNOWBANK CREEK
BELL - IRVING RIVER
WOVERINE CREEK
SWAN LAKE
CRANBERRY RIVER
KITWANGA LAKE
LAVA LAKE
MOUNT HERMAN
SKEENA
TELKWA

FIGURE 6-7 ENVIRONMENTAL AND TECHNICAL CORRIDOR PREFERENCES

TABLE 6-2

COMPARISON OF CORRIDOR PREFERENCES GENERATION SITES TO SWAN LAKE

	Corridor Length	Direct[*1] Transmission Cost (M$)	Environmental Factors	Route Engineering Considerations
 TANZILLA STIKINE CANYON MORE CREEK ISKUT CANYON SWAN LAKE Environmental Preference	533 km Circuit Length 1130 km	516	Impact score 36; high potential for impacts on the wildlife, recreation and visual resources in the Klappan and Nass river corridor segments; development of access into what is largely isolated and untouched wilderness.	No access, avalanche zones and potential icing and high winds along the Unuk River-Treaty Creek and Taft Creek segments; poor to no access along the Klappan, Nass and Taylor river corridor segments; unstable soils along the Klappan Valley; costly due to amount of transmission line and access construction; despite development of access, difficult maintenance and poor reliability due to hazards and remoteness.
 TANZILLA STIKINE CANYON MORE CREEK ISKUT CANYON SWAN LAKE Technical Preference	Corridor Length 422 km Circuit Length 920 km	406	Impact score 39; high potential for impacts on the recreation and visual resources in the Snowbank Creek segment and the Eddontenajon, Kinaskan Lake segments.	Avalanche zones on the east side of the Iskut Valley and in the Snowbank Creek segment; good access provided by Highway 37 facilitates transmission line construction and maintenance and helps achieve reliability.

[*1] 1981 dollars; does not include inflation, corporate overhead or interest during construction. Total costs including these factors would be 4 to 4.5 times the costs shown.

TABLE 6-3

Environmental Data for Technical and Environmental Corridor Preferences between Generation Sites and Swan Lake*

Generation Sites to Swan Lake

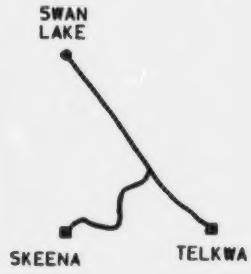
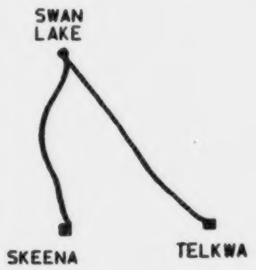
Environmental Preference (via Klappan, Nass, Unuk-Treaty, Taft)

Segment	Number of High and Severe Impacts	Major Discipline Impacts
Three Sisters Range	3	terrain
Thatue Mountain	3	wildlife
Klappan River	8	wildlife
Nass River	9	wildlife
Taylor River	3	visual resources
Mount Kologet	2	wildlife
Unuk River-Treaty Creek	6	visual resources/ terrain
Taft Creek	2	terrain
TOTAL	36	
Technical Preference (via Iskut, Highway 37)		
Zechtoo Mountain	2	recreation/ socio-economic
Eddontenajon Lake	4	visual/recreation
Kinaskan Lake	9	visual/recreation/ wildlife
Telegraph Trail	6	wildlife/forestry
Snowbank Creek	8	recreation/terrain/ forestry
Bell Irving River	9	recreation
Wolverine Creek	1	terrain
TOTAL	39	

*Note: This table has been developed for comparative purposes. Those corridors common to both preferences have been omitted.

TABLE 6-4

COMPARISON OF CORRIDOR PREFERENCES
SWAN LAKE TO TELKWA AND SKEENA

	Corridor Length	Direct*1 Transmission Cost (M$)	Environmental Factors	Route Engineering Considerations
 Environmental Preference	307 km Circuit Length 621 km	216	Impact score 28; high potential for forestry and socio-economic impacts in the Kitwanga Lake segment; land use concern in the Mount Herman segment.	No existing access along the upper portion of the Zymoetz River segment; along the lower Zymoetz a second transmission line would follow less stable locations than the existing line; Highway 16, the CNR, a gas pipeline, and an existing 500 kV transmission line are all confined to the Skeena River Valley just northeast of Terrace.
 Technical Preference	Corridor Length 366 km Circuit Length 560 km	199	Impact score 42; high potential for impacts on the recreation and visual resources in the Lava Lake segment; high potential for forestry and socio-economic impacts in the Kitwanga Lake segment.	Good access; potential flood hazard from the Kitsumkalum River.

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*1 1981 dollars, does not include inflation, corporate overhead or interest during construction. Total costs including these factors would be 4 to 4.5 times the costs shown.

TABLE 6-5

Environmental Data for Technical and Environmental Corridor Preferences between Swan Lake and Skeena and Telkwa

Environmental Preference

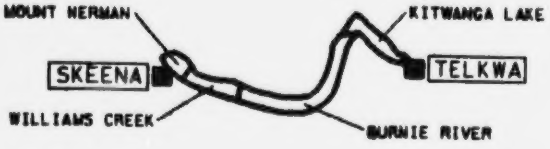
Segment	Number of High and Severe Impacts	Major Discipline Impacts
Kitwanga Lake	19	forestry/socio-economic
Zymoetz Creek	4	wildlife/forestry/visual/terrain
Trapline Creek	2	forestry/terrain
Thornhill Mountain	1	terrain
Mount Herman	2	agriculture/land use
	--	
TOTAL	28	

Technical Preference

Segment	Number of High and Severe Impacts	Major Discipline Impacts
Cranberry River	2	heritage/forestry
Lava Lake	21	recreation/heritage/forestry/terrain/visual
Kitwanga Lake	19	forestry/socio-economic
	--	
TOTAL	42	

ENVIRONMENTAL CORRIDOR PREFERENCE

(REFERENCE FIGURE 6-3E)


MOUNT HERMAN
KITWANGA LAKE
SKEENA
TELKWA
WILLIAMS CREEK
BURNIE RIVER

TECHNICAL CORRIDOR PREFERENCE

(REFERENCE FIGURE 6-5(3))

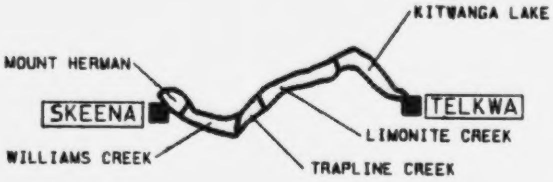
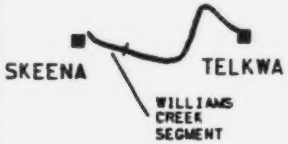
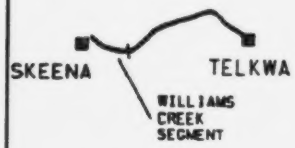

KITWANGA LAKE
MOUNT HERMAN
SKEENA
TELKWA
LIMONITE CREEK
WILLIAMS CREEK
TRAPLINE CREEK

FIGURE 6-8
ENVIRONMENTAL AND TECHNICAL CORRIDOR PREFERENCES
TELKWA TO SKEENA

TABLE 6-6

COMPARISON OF CORRIDOR PREFERENCES
TELKWA TO SKEENA

	Corridor Length	Direct[*1] Transmission Cost (M$)	Environmental Factors	Route Engineering Considerations
	151 km **Circuit Length** 151 km	66	Impact score 4. Potential for terrain, vegetation and visual impacts in the Burnie River segment.	High mountain pass over 1800 m in the Burnie River segment, possible severe wind and icing conditions, very little available access.
Environmental Preference				
	Corridor Length			
	141 km **Circuit Length** 141 km	52	Impact score 7; high potential for impacts on terrain and potential for vegetation and visual impacts in the Limonite Creek segment; potential terrain and forestry impacts in the Trapline Creek segment.	Follows existing line to the Zymoetz River; access available along most of the existing line; terrain problems in the Limonite Creek segment can be avoided by a second line.
Technical Preference				

[*1] 1981 dollars, does not include inflation, corporate overhead or interest during construction. Total costs including these factors would be 4 to 4.5 times the costs shown.

TABLE 6-7

Environmental Data for Technical and Environmental Corridor Preferences between Telkwa and Skeena*

Environmental Preference

Segment	Number of High and Severe Impacts	Major Discipline Impacts
Burnie River	4	terrain/vegetation/ visual
	--	
TOTAL	4	

Technical Preference

Segment	Number of High and Severe Impacts	Major Discipline Impacts
Limonite Creek	5	terrain/visual/ fisheries/forestry
Trapline Creek	2	terrain/forestry
	--	
TOTAL	7	

*Note: This Table has been developed for comparative purposes. Those corridors common to both preferences have been omitted.

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7 Conclusions and Recommendations

Three 500 kV transmission lines would be required to transmit energy from the proposed hydro-electric generation sites on the Stikine and Iskut Rivers to the provincial electric system. It is proposed that these transmission lines connect to the grid at the Telkwa Substation near Smithers and possibly at the Skeena Substation near Terrace.

The corridors shown in Figure 7-1 are recommended for further, detailed route location studies, based on the preliminary planning studies summarized in this report.

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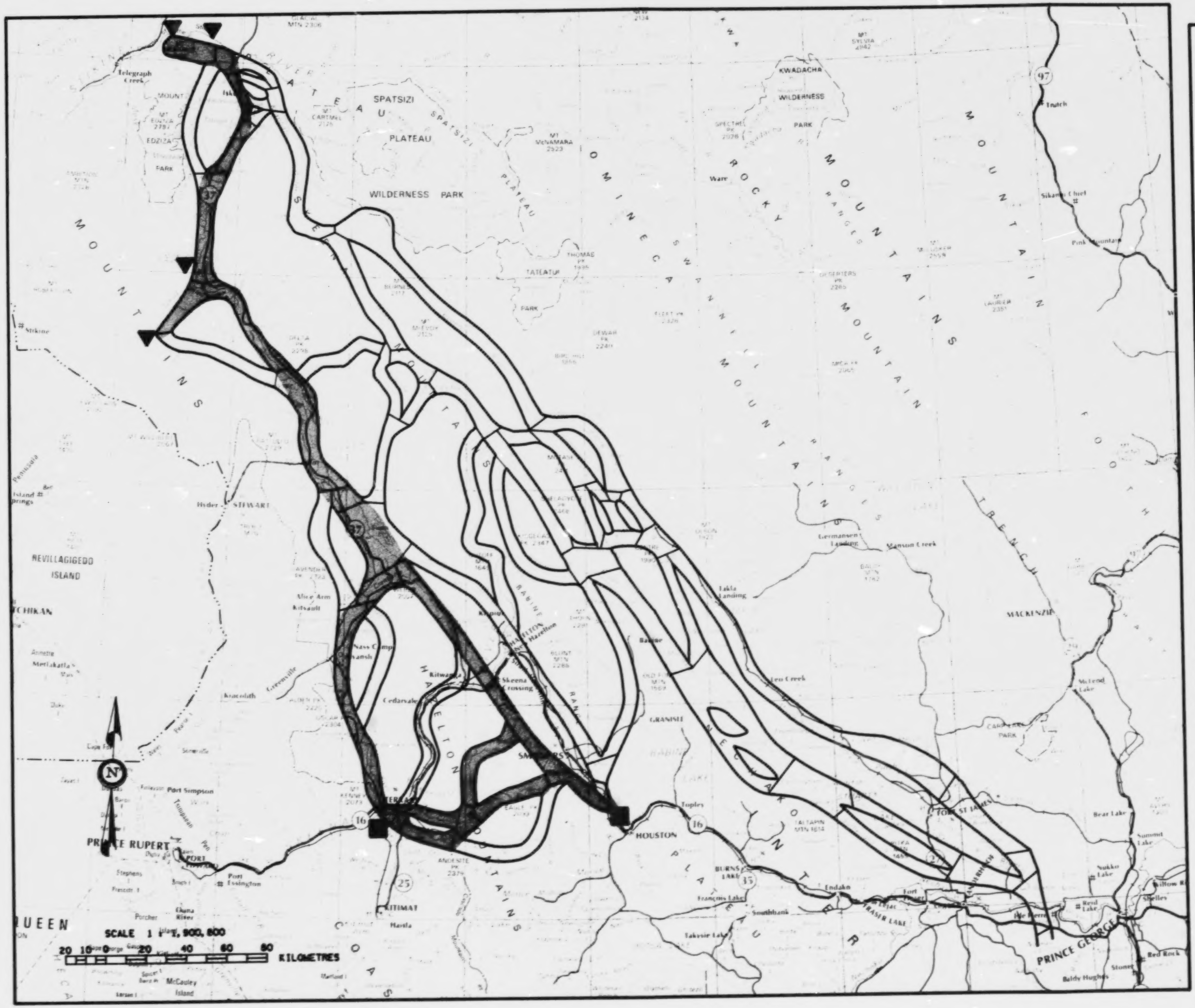
Telegraph Creek
MOUNT EDZIZA PARK
SPATSIZI PLATEAU WILDERNESS PARK
KWADACHA WILDERNESS PARK
OMINECA MOUNTAINS
SKEENA MOUNTAINS
ROCKY MOUNTAINS
HAZELTON MOUNTAINS
NECHAKO PLATEAU
COAST MOUNTAINS
ROCKY MOUNTAIN TRENCH
STEWART
Hyder
REVILLAGIGEDO ISLAND
Stikine
Kitwanga
Skeena Crossing
Hazelton
Cedarvale
Nass Camp
Kitsault
Takla Landing
Germansen Landing
Manson Creek
Fort St. James
Babine
GRANISLE
Topley
HOUSTON
BURNS LAKE
Francois Lake
Fraser Lake
Endako
Vanderhoof
Fort St. James
MACKENZIE
Carp Lake Park
McLeod Lake
Bear Lake
Summit Lake
Tudyah Lake
Sikanni Chief
Pink Mountain
PRINCE RUPERT
Port Simpson
Port Essington
TERRACE
SMITHERS
KITIMAT
PRINCE GEORGE
16
25
35
37
97
N
SCALE 1 : 1,900,800
20 10 0 20 40 60 80
KILOMETRES

FIGURE 7-1

STIKINE/ISKUT TRANSMISSION STUDIES

CORRIDORS RECOMMENDED FOR FURTHER INVESTIGATION

■ SUBSTATION

▼ GENERATING STATION

NOTE: SUBSTATIONS NEAR TERRACE AND SMITHERS NOW EXIST.

APPENDIX I

THE STIKINE-ISKUT HYDROELECTRIC GENERATION PROJECTS

APPENDIX I

THE STIKINE-ISKUT HYDROELECTRIC GENERATION PROJECTS

STIKINE CANYON PROJECT

The Stikine Canyon project is the upstream of the two projects being studied on the Stikine River. The damsite is located in the Grand Canyon of the Stikine approximately 25 km downstream of the Highway 37 river crossing. Alternative layouts, axes and types of construction have been considered for the Stikine Canyon Dam and the most promising have been selected. These consist of either a combination of two dams (concrete arch and rockfill or twin concrete arches) at axis Z or a single rockfill dam at axis X. The powerhouse for the dam at axis Z would have a capacity of 915 MW and a maximum gross head of 262 m would be provided. The dam would create a reservoir with a total length of 103 km, an average width of 1.25 km and a surface area of 12 700 ha. Live storage of 3800 x 106 cubic metres would be provided with a drawdown of 45 m.

TANZILLA PROJECT

The Tanzilla damsite is located in the Grand Canyon of the Stikine 23 km downstream from the Stikine Canyon site and about 5 km upstream from the Tanzilla River confluence with the Stikine River. At the damsite the canyon is V-shaped with walls in general considerably less steep than those at Stikine Canyon.

The Tanzilla powerhouse would be located about 7 km downstream from the damsite. A power tunnel would provide a nearly direct connection between the power intake at the dam and the underground powerhouse which would have a capacity of 915 MW. The dam would be slightly less than 200 m high and in conjunction with the power tunnel a gross head of 252 m would be developed. The Tanzilla project would be operated on a run-of-the-river basis utilizing the storage provided by the Stikine Canyon reservoir. The Tanzilla reservoir which would be contained within the Grand Canyon would have surface area of only 900 ha and an average width of 0.4 km.

ISKUT CANYON PROJECT

The major damsite in the Iskut basin would be located in the Iskut Canyon some 80 km upstream of the confluence of the Iskut and Stikine Rivers. A powerhouse some 1.5 km downstream of the damsite would have a capacity of about 780 MW. The maximum gross head would be 202 m. The dam in the Iskut Canyon would probably be a composite dam comprising a central concrete arch section and a concrete gravity section with an earthfill wing dam on each flank. A separate saddle dam with a maximum height of 43 m and an overall crest length of 1430 m would also be required approximately 1 km east of the main dam. The reservoir created would be 3800 ha in area. A 30 m drawdown would provide 800 x 106 cubic metres of live storage.

MORE CREEK PROJECT

Approximately 46 km upstream of the Iskut Canyon damsite More Creek flows into the Iskut River. The second generation site being studied in the Iskut basin lies on More Creek just above its confluence with the Iskut. The capacity of this site would be approximately 155 MW with a concrete arch or earthfill dam 135 m high. The powerhouse would be approximately 500 m downstream of the dam axis.

In addition it is foreseen that a small earthfill dam with a maximum height of 37 m and a crest length of approximately 200 m could be constructed on another tributary of the Iskut known as Forrest Kerr Creek. The purpose of this would be to divert the waters of Forrest Kerr Creek into the More Creek reservoir. With this diversion, flows at the More Creek project would be increased by 42 percent. The More Creek reservoir would provide live storage of 1300 x 106 cubic metres with an area of 4100 ha and a drawdown depth of 40 m.

APPENDIX II

TRANSMISSION LINES AND THE ENVIRONMENT

APPENDIX II

TRANSMISSION LINES AND THE ENVIRONMENT

This appendix surveys the social and environmental consequences of transmission line construction and operation. It provides general background information to provide a better understanding of the planning process. Although examples from northwestern B.C. are used, this section is not a summary of the Stikine-Iskut preliminary environmental studies.

1. Regional Resource Development

For most transmission projects, the social and environmental impacts are felt in the immediate vicinity of the transmission line. However, a transmission project may have wider regional implications than is normally the case when crossing territory relatively untouched by modern development. For instance, one of the most important aspects of the Stikine-Iskut development for the province as a whole will be that it is part of the beginnings of modern economic development in the undeveloped portions of northwestern B.C.

Linear developments such as roads, railways, transmission lines and pipelines, will affect the location of future developments. The presence of transmission lines and of associated access roads may change the timing of additional development. Potential for recreation will increase with new or improved access, however crude, and with greater knowledge of the area. Timber harvesters may be able to upgrade access roads built for transmission construction and maintenance. Conversely, B.C. Hydro may be able to take advantage of existing or planned logging roads. Improved transportation may lower slightly the initial costs of developing a new mine. More directly, if the electrical requirements for a mine are large enough and close enough the costs of transmitting power to the mine site may be reduced.

In sum, the presence of new or improved access and of a closer supply of electricity may improve slightly the economic viability of natural resource developments in the region. New recreational opportunities may present themselves in specific circumstances.

2. Forestry

Loss of productive forest land base is an important socioeconomic and environmental consequence of constructing transmission across forest landscapes. This loss means a long term reduction in available timber and in the annual allowable cut. Clearly, it is desirable to minimize forest losses by avoiding productive sites wherever possible.

As noted previously, access for transmission line construction can benefit logging activities. However, in some circumstances the transmission line right-of-way may limit or prevent access to timber stands. Isolated stands may become too small or inaccessible for efficient harvesting, especially in steep, rocky or broken terrain. The existence of transmission lines may restrict rock blasting for access construction, the movement of heavy equipment and helicopter logging.

Awareness of these problems and close liaison with the Ministry of Forests and the forest industry provides a basis for construction and clearing procedures that minimize these potential impacts. In general, careful scheduling, access road routing and right-of-way clearing can avoid or mitigate these problems. But the long term loss of forest land productivity on the right-of-way cannot be avoided.

3. Fisheries

As the present transmission towers in the Skeena River demonstrate, fish and transmission lines can co-exist without difficulty. Generally, fish populations will not be harmed by nor benefit significantly from transmission line construction or operation.

If problems occur, they arise primarily during construction. Poorly installed culverts can block fish migration. Spawning beds can be damaged by surface runoff, by silt from improperly drained rights-of-way, silt laden fill, or access roads, and by careless operation of heavy equipment in or near stream beds. Loss of stream bank vegetation can alter terrestrial insect populations, which are important food sources for fish. In addition, loss of shoreline shade can increase water temperatures, which can affect fish populations in sensitive areas.

These problems can be avoided or mitigated by worker education, by careful construction scheduling, by carefully following normal B.C. Hydro construction standards, and by enforcing existing environmental regulations.

Increased sportfishing opportunities can be created by new or improved access roads or cleared rights-of-way but in some instances this can result in overfishing. In those cases, fishing regulations may need to be changed or revised fish limits or closures may be required.

4. Wildlife

Transmission right-of-way logging, clearing and vegetation management can alter wildlife habitat. Cleared rights-of-way may change some migration patterns. Nevertheless, the direct impacts of transmission lines on wildlife generally are few.

Right-of-way clearing is associated with the "edge effect", with increased habitat diversity in forested regions and with the addition of low-growing forage vegetation. These benefit species preferring open or disturbed areas, such as moose, deer, elk, black bear, coyote, lynx, fox and ruffed grouse. But species that depend upon mature forests, such as caribou, red squirrel, marten, wolverine and spruce grouse, may be affected adversely. Direct impacts vary greatly and depend upon location, species, climate and particular habitat changes.

In contrast, the indirect impacts on some wildlife species can be serious. Remoteness provides a form of protection for many wildlife populations. A transmission line can bring some wildlife populations into regular contact with the works of man for the first time.

New or improved access increases hunters' ability to locate and to kill game. If hunting pressure is too intense, wildlife populations will decline. Wildlife productivity may be decreased by removing too much of the breeding population. In previously inaccessible areas, improved access can result in overhunting.

Obviously, when fewer animals are sought by more hunters, hunter success rates will drop. Competition between guides and outfitters, sports hunters, and those persons hunting for food will intensify and the overall quality of the hunting experience will decline.

The impact of hunting on wildlife is largely a function of the intensity of resource management efforts. Many hunters have off-road and all-terrain vehicles and are more mobile and better equipped than the conservation officers. Hunting and other impacts of new or improved access on wildlife can be mitigated in theory, but the Ministry of Environment requires sufficient resources to cope with the situation.

The impact of transmission line development on trapping is expected to be negligible since habitat modifications are usually minor. A cleared right-of-way could improve access enough to allow a trapper to cover territory more efficiently. On the other hand, this improved access near a population centre could result in increased poaching, theft, or vandalism of the trapper's property. Therfore, improved access could have both beneficial and detrimental effects on trapping activities.

5. Recreation and Tourism

Hunting and fishing are prominent outdoor recreation activities. Other significant activities are sightseeing, hiking, camping, mountaineering, cross-country skiing and snowmobiling. Understandably, outdoor recreation facilities and activities are most common near population centres and where easy access is available. However, as British Columbia's active guide and outfitter industry demonstrates, recreation in the wilderness is popular too.

The quality of recreational and tourist experiences depend often upon images of and activities on rugged, natural landscapes. Any adverse impact a transmission line may have on the natural landscape diminishes the quality of recreational and tourist experiences indirectly. The principal direct impacts are the visual impact of transmission lines, to the extent that they are unpleasing to the eye and detract from natural images, and changes in the distribution of recreation activities caused by new or improved access.

6. Agriculture

The most important long term consequence of transmission line development for the farmer is loss of productive land due to the presence of towers. In general, the area lost is up to twice the area of the tower base. Guyed towers may have the most impact on intensive agriculture because of the larger affected area at each tower site. Route design can reduce land loss significantly by placing towers along farm, field or natural boundaries. Less land is lost when towers are placed in line with the direction of cultivation instead of diagonally. Time lost while going around towers follows the same pattern as land loss. Both are relatively small but cumulative losses to the farm operation. They can be mitigated but not eliminated entirely.

Construction can cause crop damage, soil compaction, weed control problems, disruption of farm operations and damage to fences and other farm property. Interference with the movement of irrigation equipment and of drainage water are of particular importance because they affect larger areas beyond the immediate vicinity of the rights-of-way. These short term impacts are important to the individual farm operators but they do not reduce land capability in the long term.

Local farmers and ranchers can use newly cleared rights-of-way. The cost of clearing and removing stumps is often a major impediment to new agricultural development. In grazing areas, newly cleared land is of great value. For example, the grazing capacity of conifer forests is increased five to ten times with clearing. Since local ranchers would not normally clear the forest because of the cost, the long term effects of transmission lines on ranching can be positive.

In general, the impact of transmission lines on agriculture varies with the intensity of existing and future agricultural development which depends, in turn, upon the agricultural capability of the land and market forces. In areas capable of intensive cultivation, transmission lines can be disruptive and have a cumulative negative effect. At the same time, in undeveloped areas with low agricultural potential, right-of-way clearing and removal of stumps result in rapid development of improved pasture and hayfields along rights-of-way.

7. Land Use

Transmission lines are a form of land use. They interact with existing land uses and create new ones as the previous discussion of agricultural land illustrates. General congestion of human activity is often a complication in urban areas, where no single land use is an obstacle in itself but many factors combine to create a complex situation. In general, the impact of transmission lines depends upon the character and density of human settlements.

Most land use conflicts are direct and distinct. Some existing features like airports must be avoided. Buildings are avoided, if at all possible, but on occasion they must be removed. Other facilities, such as long distance telephone cables, railroad communications systems and pipelines, present specific technical design problems where the transmission line parallel them. In small watersheds, transmission construction and continued cleared rights-of-way can alter small scale drainage patterns and runoff levels and affect the quality of domestic water supplies. Land use conflicts are quite specific and immediate.

Land use planning is essentially an attempt to avoid or to minimize potential conflicts depending upon the circumstances. At the same time, some long term implications of transmission line routing are subtle.

Transmission lines can influence future patterns of land use and of community development by becoming landmarks and boundaries and by changing the way people think about the land. In this respect, transmission lines are similar to highways, pipelines and railroads.

8. Heritage Resources

Heritage resources are sites, landscapes or objects with archaeological, historical, architectural, palaeontological or scenic significance. Significance is a value judgement based upon an appreciation of British Columbian culture and history, and upon the location, rarity, vulnerability, distinctiveness, and representativeness of a specific site, landscape or object.

Generally, transmission line projects need not disrupt nor destroy heritage resources. Usually, transmission lines can span over or avoid known heritage sites. Routing of access roads must be given particular attention as they can impact more directly on heritage sites than other transmission construction activities.

If an archaeological site is discovered accidently during construction, inadvertent damage may occur. Field personnel, assisted by persons with archaeological experience, need to be able to recognize archaeological remains and to be aware of the need to protect and to preserve heritage sites. If necessary, salvage archaeology can be done.

In addition to the direct consequences of transmission line construction, new or improved access to remote heritage sites or trails will increase the probability of inadvertent damage or of vandalism. Also, the visual impact of a poorly located transmission line could create problems in specific circumstances near historical sites and sites of architectural significance. Nevertheless, these indirect impacts on heritage resources can be avoided or minimized with careful planning.

9. General Social and Economic Concerns

In British Columbia, the social and economic fabric of the province depends heavily upon the exploitation of natural resources. Therefore, the general, incremental environmental impact of a transmission line project upon future natural resource use will determine a project's principal social and economic consequences.

Apart from the direct effects of transmission lines and other developments on every day life, a major social impact is change itself. Thus, the initial social impact of a project occurs far in advance of construction. The anticipation and assessment of the social, economic and environmental consequences of a project are, in fact, part of these consequences. The project is a social and political intrusion upon the community by the participants in the debate during the planning process. This debate changes local residents' attitudes and expectations about their community. These social impacts are subtle, subjective and personal. Nevertheless, they are no less important in the long term than the relatively brief, highly visible social and economic impacts experienced during transmission line construction.

Transmission line construction involves relatively small areas of land at any one time. Like the transmission lines themselves, the direct social and economic impacts of construction activities are distributed linearly. Impacts vary depending upon the proximity of construction to local communities and commercial services, the size and nature of construction crew accommodations, and construction schedules.

Generally, the economic and social impacts of construction activities are small and circumstantial. Certainly, any economic boom and bust cycle associated with transmission construction would be short-lived and sporadic. The significant long term social and economic consequences relate to the impact of the transmission line and its access roads upon patterns of natural resource use and of regional development.

APPENDIX III

INITIAL CLEARING STANDARDS AND VEGETATION MANAGEMENT OF RIGHTS-OF-WAY

APPENDIX III

INITIAL CLEARING STANDARDS AND VEGETATION MANAGEMENT OF RIGHTS-OF-WAY

1 GENERAL

B.C. Hydro defines vegetation management as "the practical art of managing vegetation at the lowest long-term cost with the greatest resource, social, and scenic benefits while meeting engineering needs." Vegetation management techniques protect and enhance desirable climax vegetation where possible.

Vegetation management on transmission line rights-of-way is essential in order to assure constant reliability and safety of the transmission system, to create safe conditions for line maintenance personnel and the public, to reduce or eliminate fire hazards, to control erosion and to improve aesthetics.

Initial clearing removes any tall-growing plant species which could endanger the line. The standard of clearing in a particular area is determined by compatible land use requirements, access requirements for maintenance, method and cost of right-of-way maintenance, overall project economics, aesthetic requirements, soil stability and environmental protection. Areas of disturbed ground cover are reseeded. Prior to initial clearing, objectives for future vegetation management are established.

A minimum clearance of 6.0 m between the conductors and any grounded object, such as a tree, is required for safe and secure operation of 500 kV transmission lines

2 INITIAL CLEARING STANDARDS

Four basic standards are used in initial clearing of rights-of-way.

2.1 Standard A

The natural ground surface is disturbed as little as possible. Only handheld equipment is used. Stumps are not removed and debris over 15 cm diameter is left flat on the ground. Plant species, compatible with the transmission lines, are retained for ground cover. This clearing standard is used near streams and on wet, steep or unstable terrain.

2.2 Standard B

Similar to standard A, but all debris is removed by rubber-tired equipment or cable yarding machinery (with spar). This standard, in which stumps are not removed, is used on sensitive terrain where debris removal is required. Disturbance of soil and low growing vegetation is minimized as much as possible. Tracked equipment is not permitted.

2.3 Standard C

In this standard tracked equipment is used to remove all trees, brush, and stumps up to 60 cm in diameter. Debris is removed and the disturbed terrain is groomed and seeded to grass. This clearing method is only used on stable ground and provides grazing for cattle.

2.4 Standard D

Similar to standard C, but all stumps are removed. Disturbed terrain is groomed and seeded to grass for range and pasture, or cultivated for other agricultural uses.

3 INITIAL CLEARING METHODS

3.1 Manual Clearing

New rights-of-way can be cleared by hand or by mechanical means. Manual clearing methods include the use of all hand operated tools and equipment. Examples are handsaws, axes, machetes, sandviks, brushcutters, weedeaters, circular saws, and chain saws.

Terrain topography and conditions may be such that manual methods for initial clearing are the only option. In areas where abundant ground covers and low brush are present, selective cutting rather than machine clearing may be prudent to avoid excessive maintenance costs in the future. Possible future uses of the right-of-way such as farming, grazing, tree farms, and recreational opportunities all play a role in determining if manual clearing is the desirable method or not. Wildlife habitat is often enhanced by manual clearing.

3.2 Machine Clearing

Machine clearing uses blade, bucket and backhoe equipment, either on tracks or rubber tires.

Cleared rights-of-way are uniform and provide accessible terrain for future maintenance. Ranching and farming needs are served better when and where such needs are predetermined.

4 VEGETATION MANAGEMENT ON ESTABLISHED RIGHTS-OF-WAY

4.1 Security of Service

Land under B.C. Hydro's more than 55,000 kilometres of powerlines must be kept free of tall-growing trees and brush to avoid contact with energized conductors which may cause service interruptions and pose a hazard to B.C. Hydro employees or the public.

In addition, to facilitate access for inspection and repairs, heavy brush must be cleared along right-of-way roads and near all structures.

4.2 The Major Troublesome Tree Species

Tall-growing deciduous trees and brush such as red alder, black cottonwood, trembling aspen, birch, bigleaf maple, and Douglas maple pose the major problem on rights-of-way. These species not only have an enormous growth rate, but also are capable of regenerating quickly after they are cut. Each cut stem may result in multiple stem regeneration, compounding future vegetation management problems. All are pioneer trees which may establish quickly from seed on cleared or disturbed land. Generally, these plant species are shade intolerant so that the presence of low-growing ground covers will discourage their reintroduction.

Although tall-growing coniferous trees cannot be allowed on the right-of-way, their growth rate is much slower and regeneration does not usually occur when they are cut under the lowest whorl of branches.

4.3 Vegetation Management Techniques

Available techniques include physical, chemical, and biological controls.

Physical Controls may be done manually with machetes, axes, sadviks, or other handheld brushcutters; and mechanically with self-propelled brushcutters.

Chemical Controls are done with herbicides which are either selective or applied selectively.

Biological Control involves the use of a living organism to control or abate another living organism.

4.3.1 Physical Controls

Manual control techniques have already been mentioned under Manual Clearing (3.1). These methods are used extensively and successfully on established rights-of-way. Selective cutting permits retention of desirable growth. Regeneration of deciduous trees and shrubs may necessitate the minimal use of site-specific herbicide applications.

Mechanical control techniques include mowers which vary in size from grass mowers to brushcutters to hydro-axes. Hydro-axes will cut fir trees up to 35 cm in diameter. Mowers may be hand-pushed, attached to trucks or tractors, or self-propelled.

The principal equipment used on high voltage transmission line rights-of-way is the self-propelled hydro-axe on large rubber tires. Terrain topography, stumps, and rocks on rights-of-way limit the use of the hydro-axe. The non-selective treatment of vegetation by the hydro-axe may at times be a disadvantage, although ground covers often recover and spread quickly after treatment. As with manual controls, a follow-up site-specific herbicide treatment which selectively removes unwanted deciduous growth prone to regeneration, may be necessary.

4.3.2 Chemical Controls

Herbicides are used to control unwanted plant growth chemically. Although the use of herbicides is unavoidable, it is B.C. Hydro policy to minimize their use through selective and site-specific application techniques which do not cause an unreasonable adverse effect on desirable ground-covering plant species and our environment. On the right-of-way, herbicides are often used in conjunction with physical controls.

4.3.3 Biological Controls

Biological control of weeds, generally has not been a great success story. Insects, fungi, and, to a lesser degree, plant eating mammals are the principal organisms usually considered as biological control agents of weeds.

Insects which feed only on a few selected plant species (host specific insects) will not eradicate these plant species completely as this would be tantamount to self annihilation. The use of insects which feed on many plant species (multiple host insects) to control vegetation on the right-of-way is not feasible as the insects would have to be programmed to stop eating when they reach agricultural, horticultural and forestry crops.

Although research into fungi as weed controlling agents holds some promise for the future, at present the same limitations as those mentioned for insects apply.

Plant-eating mammals provide some measure of biological control. Moose browsing on willow have in some areas produced low dense growth, but cannot be considered as a widespread effective control. Grazing of cattle in pastures or on the range is an effective control and can reduce the fire hazard posed by high, dead grasses on rights-of-way in the spring.

However, desirable and undesirable plant species on rights-of-way represent a totally different challenge than the weeds normally encountered in cultural practices of agriculture, horticulture, and forestry.

Open spaces of land, created by whatever circumstances, are quickly colonized by pioneer species of plants. Eventually dominant species establish themselves as climax vegetation.

Climax tree species in the British Columbia Pacific Forest Regions and some Interior Districts are coniferous, while other regions have a mixture of coniferous and deciduous climax trees. All of these and a number of pioneer tree species are incompatible with powerlines on rights-of-way.

Smaller pioneer tree and brush species, many climax deciduous and broadleaved evergreen brush species, and ground covering plants in the understory are abundant in many parts of British Columbia. Many of these plant species will thrive in the absence of the climax forest canopy and are compatible with engineering needs for powerlines on rights-of-way. Native and cultured grasses together with many herbaceous plants may be used to further compliment this flora. As no two plants can fill the same niche, encouragement of desirable plant species discourages and often virtually eliminates the growth of undesirable plant species, minimizing future maintenance costs.

Biological control of undesirable plant species on transmission line rights-of-way is achieved by manipulating the desirable plant species to form a relatively stable plant community. This plant association, a type of climax vegetation, may be comprised of native vegetation to support wildlife, grasses to support ranching and farming needs, farm crops, tree nurseries, Christmas gree farms, recreational areas, or any other multiple uses which meet specific needs.

Biological control has many advantages. Desirable climax vegetation tends to suppress undesirable vegetation, long-term vegetation management costs are reduced, aesthetically it is more acceptable, multiple uses of rights-of-way are served better, fish and wildlife concerns are better addressed, farming and ranching needs are taken into consideration, public concerns are lessened and erosion problems are decreased. Therefore, biological control by plant competition should be the main thrust of vegetation management on the rights-of-way.

5 INTEGRATED PEST MANAGEMENT (IPM)

A modern term used in pest control is: "Integrated Pest Management". This term implies the judicious integrated use of all known pest control techniques, be they physical, chemical, or biological, to achieve maximum results at affordable costs with minimal impact on our environment.

The objective of maximum biological control cannot be achieved without the judicious, selective use of herbicides to control the unwanted, tall-growing deciduous plant species and to prevent regeneration.

Although B.C. Hydro recognizes the need for all available herbicide application techniques, aerial and ground-applied broadcast herbicide applications are rare. Emphasis is given to selective and highly site-specific herbicide applications which only eliminate the unwanted tall-growing trees and shrubs while preserving desirable growth.

Use of herbicides will diminish further as biological control progresses.

6 PESTICIDE LEGISLATION

B.C. Hydro strictly adheres to federal and provincial pesticide legislation. All herbicide applications on public and private land are done under Pesticide Use Permits. Such permits are granted by the administrator of the B.C. Ministry of Environment's Pesticide Control Branch.

The Pesticide Control Committee, comprised of representatives of the provincial ministries of environment, agriculture, forestry, and health, and the federal ministry, Environment Canada, provides the administrator with advice and suggests conditions under which a permit may be granted. Government experts frequently inspect and monitor herbicide application sites.

Herbicide applications are made by contractor employees or B.C. Hydro employees under continual supervision of provincial government certified pesticide applicators.

APPENDIX IV

STATIONS - GENERAL FUNCTION AND DESCRIPTIONS

APPENDIX IV

STATIONS - GENERAL FUNCTION AND DESCRIPTION

A substation is an assembly of equipment for the purpose of switching system components and/or changing or regulating the voltage of electricity.

Substations are integral components of an electric power system. They provide the mechanism for efficient and safe system operation. They may be large or small and may be controlled automatically or manually. Manual control can be executed either by a remote operator or by a local attendant. Usually, large substations employ a combination of automatic and remote manual operations.

Substations provide one or more of the following functions:

1) Switching is the connection or disconnection of components of the electric system. This is accomplished with circuit breakers and disconnect switches.

2) Voltage Transformation involves stepping up or stepping down voltage using transformers.

3) Voltage Control holds the system voltage within prescribed limits. Voltage regulating transformers, voltage regulators, capacitors, synchronous condensers and reactors are used most often during this process.

In addition, substations contain equipment for system data collection, apparatus monitoring and protection, and evaluation of system conditions.

Power from generating stations is received by substations where some of the power is used for local loads. The rest of the power is transmitted to other substations to supply their respective loads.

Series capacitors may be required to facilitate the transfer of power and improve the operating stability of the system for extra long high voltage transmission lines. Capacitors are connected in series with the line. These capacitors are installed generally in the middle of the line and construction of a separate capacitor station is usually required. Capacitor stations are usually accommodated within the boundaries of the transmission line right-of-way.

This obviates the need for additional land purchase. In some circumstances, such installations can be located at either end of the line within the substation which can require expansion of the substation site.

In the design of high voltage substations, consideration must be given to basic station configuration as determined by equipment to be installed and desired system layout. An increase in voltage and/or system reliability requirements usually will increase the quantity or size of equipment needed.

Land allocation for a substation is directly related to the number of transmission lines to be connected to the substation and to the quantity of equipment to be installed there. For a predominantly switching substation with six connected 500 kV transmission lines such as the planned Stikine Collector, 8 to 10 hectares of relatively flat and stable terrain are needed. (The term "collector station" is used in the main report to designate those substations which directly accept power from more than one generation source.) However, if transformation to supply local loads and series capacitors are required at the site, the acreage could double.

APPENDIX V

ENVIRONMENTAL IMPACT RATINGS BY SEGMENT AND ESTIMATED TOTAL COST OF ENVIRONMENTAL ALTERNATIVES

SCALE	-5	-4	-3	-2	-1	0	1	2	3	4	5
DEFINITION	VERY SUBSTANTIAL BENEFIT	SUBSTANTIAL BENEFIT	MODERATE BENEFIT	LOW BENEFIT	SLIGHT BENEFIT	NO IMPACT	SLIGHT IMPACT	LOW IMPACT	MODERATE IMPACT	HIGH IMPACT	SEVERE IMPACT
TERRAIN/ HYDROLOGY	THE CONSULTANT'S IMPACT RATING SCALE DID NOT USE NEGATIVE VALUES.					-WELL DRAINED -LOW RELIEF -GOOD ACCESS	-LOW TO MODERATE RELIEF -SOME NEW ACCESS REQUIRED -GOOD DRAINAGE	-LOW RELIEF TILL SURFACES -TILL-MANTLED TERRAIN OF LOW TO MODERATE RELIEF -FLUVIAL AND GLACIOFLUVIAL DEPOSITS	-FLOODPLAINS, FENS AND DELTAS CROSSED -TILL COVERED TERRAIN OF MODERATE RELIEF -MIXED AREAS OF TILL AND MUSKEG	-LACUSTRINE DEPOSITS -BEDROCK TERRAIN -FLOODPLAINS PARALLELED	-ALPINE TERRAIN -STEEP SLOPES WITH TILL AND COLLUVIUM -DISCONTINUOUS PERMAFROST -BOGS, FENS, SWAMPS
VEGETATION	THE CONSULTANT'S IMPACT RATING SCALE DID NOT USE NEGATIVE VALUES.					-VEGETATION NOT DISTURBED	-SLIGHT VEGETATION CHANGE -NO SIGNIFICANT PLANT COMMUNITIES -VEGETATION ALREADY DISTURBED BY LOGGING OR FIRE	-LOW VEGETATION CHANGE -NO SIGNIFICANT PLANT COMMUNITIES -SOME MATURE FORESTS	-MODERATE VEGETATION CHANGE -PLANT COMMUNITIES WELL ESTABLISHED -SIGNIFICANT PLANT DIVERSITY	-SUBSTANTIAL VEGETATION CHANGE -SENSITIVE PLANT COMMUNITIES -GREAT PLANT DIVERSITY	-SIGNIFICANT VEGETATION CHANGE -LOSS OF IMPORTANT PLANT COMMUNITIES -GREAT PLANT DIVERSITY -PRESENCE OF RARE SPECIES
SOCIO-ECONOMIC			-SOME SEASONAL EMPLOYMENT OPPORTUNITIES	-A FEW SEASONAL EMPLOYMENT OPPORTUNITIES	-SEASONAL EMPLOYMENT POSSIBLE		-SLIGHT DISRUPTION OF LOCAL ECONOMYY -SLIGHT SOCIAL DISRUPTION -SOME ECONOMIC STIMULATION -WORK CAMPS IN VICINITY, COMMUNITY ABLE TO COPE	-LOW DISRUPTION OF LOCAL ECONOMY -SOME ECONOMIC STIMULATION -WORK CAMPS IN VICINITY, LITTLE SOCIAL DISRUPTION	-MODERATE DISRUPTION OF LOCAL ECONOMY -NO ECONOMIC BENEFITS -PRESENCE OF CAMPS NEARBY, SOME SOCIAL DISRUPTION	-HIGH DISRUPTION OF LOCAL ECONOMY -NO ECONOMIC BENEFITS -LIMITED ABILITY TO ABSORB SOCIAL PROBLEMS DURING CONSTRUCTON -MAJOR SOCIAL DISRUPTION	-SIGNIFICANT, NEGATIVE DISRUPTION OF LOCAL ECONOMY -NO ABILITY TO ABSORB SOCIAL PROBLEMS DURING CONSTRUCTION
SETTLEMENT AND LAND USE	THE CONSULTANT'S IMPACT RATING SCALE DID NOT USE NEGATIVE VALUES.						-ROAD CROSSING -MINOR LAND USE CONFLICT	-SCATTERED LAND USE -HIGHWAY CROSSING -RAIL CROSSSING	-DISPERSED RESIDENTIAL SETTLEMENT -ALIENATED LAND -PARALLEL EXISING LINEAR DEVELOPMENTS	-HIGH DENSITY LAND USE CONGESTION	-LAND USE CONLFICTS, EG. AIRPORTS -CONGESTION
HERITAGE RESOURCES	THE CONSULTANT'S IMPACT RATING SCALE DID NOT USE NEGATIVE VALUES.						-NO KNOWN HERITAGE SITES PRESENT -<5 UNRECORDED SITES PROBLABLE	-<5 RECORDED HERITAGE SITES PRESENT -<5 UNRECORDED SITES PROPABLE	-5-10 RECORDED HERITAGE SITES PRESENT -5-10 UNRECORDED SITES PROBABLE	->10 RECORDED HERITAGE SITES PRESENT ->10 UNRECORDED HERITAGE SITES PROBABLE	->10 RECORDED HERITAGE SITES PRESENT ->10 UNRECORDED SITES PROBABLE RARE SITES PRESENT OR PROBABLE
VISUAL RESOURCES	THE CONSULTANT'S IMPACT RATING SCALE DID NOT USE NEGATIVE VALUES.						-SLIGHT SCENIC DISTINCTION -SLIGHT VISUAL VULNERABILITY	-LOW SCENIC DISTINCTION -LOW VISUAL VULNERABILITY	-MODERATE SCENIC DISTINCTION -MODERATE VISUAL VULNERABILITY	-HIGH SCENIC DISTINCTION -HIGH VISUAL VULNERABILITY	-SEVERE SCENIC DISTINCTION -SEVERE VISUAL VULNERABILITY

TABLE V-1 ENVIRONMENTAL IMPACT RATING CRITERIA

SCALE	-5	-4	-3	-2	-1	0	1	2	3	4	5
DEFINITION	VERY SUBSTANTIAL BENEFIT	SUBSTANTIAL BENEFIT	MODERATE BENEFIT	LOW BENEFIT	SLIGHT BENEFIT	NO IMPACT	SLIGHT IMPACT	LOW IMPACT	MODERATE IMPACT	HIGH IMPACT	SEVERE IMPACT
RECREATION	THE CONSULTANT'S IMPACT RATING SCALE DID NOT USE NEGATIVE VALUES.						NO FACILITIES LOW RECREATIONAL USE POOR ACCESS	NO FACILITIES LITTLE USE LIMITED ACCESS	TRAILS CROSSED MODERATE USE GOOD ACCESS	POTENTIAL RECREATIONAL SITES HEAVY USE GOOD ACCESS	DESIGNATED PARKS AND RECREATION SITES TRAILS PARALLELED
WILDLIFE	THE CONSULTANT'S IMPACT RATING SCALE DID NOT USE NEGATIVE VALUES.						LITTLE HABITAT CARRYING CAPACITY GOOD ACCESS POOR HUNTING PROSPECTS	LOW HABITAT CARRYING CAPACITY LOW HUNTING PROSPECTS GOOD EXISTING ACCESS	MODERATE HABITAT CARRYING CAPACITY GOOD ACCESS MODERATE HUNTING POTENTIAL MODERATE WILDLIFE POPULATIONS	HIGH HABITAT CARRYING CAPACITY GOOD HUNTING POTENTIAL POOR ACCESS IMPORTANT WILDLIFE POPULATIONS	EXCELLENT HABITAT CAPABILITY SIGNIFICANT WILDLIFE POPULATIONS
FISHERIES	THE CONSULTANT'S IMPACT RATING SCALE DID NOT USE NEGATIVE VALUES.					NO SIGNIFICANT FISH RESOURCE VALUES	LIMITED FISH HABITAT CAPABILITIES RESIDENT FISH SPECIES SUSPECTED	MODERATE FISH HABITAT CAPABILITIES RESIDENT FISH SPECIES SUSPECTED OR PRESENT	GOOD FISH HABITAT CAPABILITIES RESIDENT FISH SPECIES PRESENT, SALMON SPECIES ARE SUSPECTED OR PRESENT	RESIDENT FISH SPECIES, MODERATE SALMON POPULATIONS	CRITICAL SPAWNING AND/OR REARING HABITATS SUPPORT HIGHLY PRODDUCTIVE SALMON POPULATIONS
FORESTRY	THE IMPACT RATING WAS REDUCED WHEREVER THERE WAS A BENEFICIAL IMPACT.					NO DIRECT OR INDIRECT IMPACT ON EXISTING ACCESS OR FOREST FACILITIES	SOME FOREST LAND	A SIGNIFICANT AMOUNT OF FORSET LAND BUT GENERALLY ON POOR SITES	75% OR MORE FOREST LAND WITH SOME GOOD SITES A HIGH PROPORTION OF MEDIUM SITES	A HIGH PROPORTION OF MEDIUM SITES SIGNIFICANT PROPORTION OF GOOD SITES	A HIGH PROPORTION OF GOOD FOREST SITES AND/OR AN ECOLOGICAL RESERVE COVERING MORE THAN 50% OF THE WIDTH OF THE SEGMENT
AGRICULTURE			THE RIGHT-OF-WAY CLEARING LEADS TO AGRICULTURAL DEVELOPMENT	THE ECONOMIC BENEFIT TO RANCH OPERATORS OF IMPROVED GRAZING CAPACITY IS SIGNIFICANT	THE ECONOMIC BENEFIT OF IMPROVED GRAZING CAPACITY OFFSETS THE IMPACTS OF TRANSMISSION LINE DEVELOPMENT ON FORAGE AREAS	NO AGRICULTURAL POTENTIAL OR THE IMPACTS AND BENEFITS ARE ROUGHLY EQUAL	THE OVERALL EFFECT OF TRANSMISSION LINE DEVELOPMENT IS INCONVENIENCE	AREAS CAPABLE ONLY OF FORAGE PRODUCTION BCLI CLASSES 4 AND 5	AREAS CAPABLE OF GROWING A NARROW RANGE OF CULTIVATED CROPS BCLI CLASS 4	AREAS OF PRIME AGRICULTURAL LAND IMPACT NOT LARGE ENOUGH TO DISCOURAGE AGRICULTURAL DEVELOPMENT	AREAS OF INTENSIVE AGRICULTURAL DEVELOPMENT BCLI CLASS 3 OR BETTER IMPACT LARGE ENOUGH TO MAKE AGRICULTURAL COMMUNITIES LESS VIABLE
MINING	THE CONSULTANT'S IMPACT RATING SCALE DID NOT USE NEGATIVE VALUES.					NO MINING	PRODUCING OR COMMITTED UNDERGROUND MINING				PRODUCING OR COMMITTED OPEN PIT MINE

TABLE V-1 ENVIRONMENTAL IMPACT RATING CRITERIA

TABLE V-2 (page 1)

ENVIRONMENTAL IMPACT RATINGS BY SEGMENT

Disciplines:
1 = Terrain/Hydrology
2 = Vegetation
3 = Socio-Economic Factors
4 = Settlement and Land Use
5 = Heritage Resources
6 = Visual Resources
7 = Recreation
8 = Wildlife
9 = Fisheries
10 = Forestry
11 = Agriculture
12 = Mining

		Impact Ratings												Impact Rating Totals	
Segment	Subsegment	1	2	3	4	5	6	7	8	9	10	11	12	Subsegment	Segment
Stikine Group - Grand Canyon	1	2	4	3	1	3	2	2	5	0	3	1	0	26	26
Stikine River	1	4	4	4	0	3	3	2	5	0	1	0	0	26	26
Three Sisters Range	1	5	3	4	1	3	3	4	3	1	2	1	0	30	30
Thatue Mountain	1	4	2	4	0	2	3	3	5	2	2	0	0	27	27
Zechtoo Mountain	1	3	3	5	2	3	3	5	3	1	2	0	0	30	30
Tsaybahe Creek	1	4	2	5	0	3	3	3	4	2	1	0	0	27	27
Ehahcezetle Creek	1	3	3	5	0	3	3	1	5	1	3	0	0	27	27
Kakiddi Creek	1	3	3	4	0	2	2	1	4	2	2	0	0	23	
	2	4	2	5	2	3	4	5	5	2	5	0	0	37	
	3	3	2	5	0	4	4	5	5	2	4	0	0	34	94
Eddontenajon Lake	1	4	2	4	2	3	5	5	3	3	2	0	0	33	33
Ealue Lake	1	4	3	4	0	3	4	4	4	2	3	0	0	31	31
Kinaskan Lake	1	4	2	4	1	2	5	5	5	2	3	0	0	33	
	2	3	2	4	2	3	5	5	5	2	3	0	0	34	67
Klappan River	1	3	2	3	1	4	3	2	5	2	3	0	0	28	
	2	4	3	3	0	3	3	3	5	1	3	0	0	28	
	3	3	2	3	0	3	4	3	5	1	2	0	0	26	
	4	3	3	3	0	2	5	3	5	1	2	0	0	27	109
Telegraph Trail	1	3	2	3	1	4	3	3	4	2	4	0	0	29	
	2	3	2	3	2	3	3	3	4	2	3	0	0	28	
	3	3	2	3	2	3	3	3	4	2	4	0	0	29	86
Iskut River	1	4	2	2	0	2	3	3	2	2	3	0	0	23	
	2	5	2	2	0	2	3	2	2	2	3	0	0	23	46
Unuk River - Treaty Creek	1	5	3	2	0	2	5	2	3	1	2	0	0	25	
	2	5	3	2	0	2	5	2	3	2	1	0	0	25	
	3	5	3	2	0	2	5	1	3	2	2	0	0	25	75
Snowbank Creek	1	5	4	3	1	2	5	4	3	2	5	0	0	34	
	2	4	3	3	2	2	3	5	3	3	4	0	0	32	66

TABLE V-2 (page 2)

Segment	Subsegment	Impact Ratings 1	2	3	4	5	6	7	8	9	10	11	12	Impact Rating Totals Subsegment	Impact Rating Totals Segment
Bell-Irving River	1	3	2	3	2	2	4	4	3	3	3	0	0	29	
	2	4	2	3	1	2	4	5	3	3	4	0	0	31	
	3	4	2	3	3	3	2	4	4	3	3	0	0	31	91
Taft Creek	1	4	1	2	0	2	3	1	3	3	2	0	0	22	
	2	4	1	2	1	3	3	2	3	3	2	0	0	23	45
Taylor River	1	3	3	2	0	2	3	2	3	2	3	0	0	22	
	2	4	4	2	0	2	4	1	3	2	2	0	0	22	44
Vile Creek	1	4	2	2	0	3	3	2	4	3	3	0	0	25	
	2	4	2	2	0	2	3	2	4	3	3	0	0	24	49
Mount Kologet	1	3	2	2	0	3	2	2	4	2	3	0	0	23	
	2	3	2	2	0	3	2	3	4	3	3	0	0	25	48
Wolverine Creek	1	4	2	3	1	3	2	3	3	2	3	0	0	26	26
Swan Lake	1	3	2	3	1	4	2	4	3	2	4	0	0	28	28
Cranberry River	1	3	2	3	1	5	2	2	2	2	4	-1	0	25	25
Kinskuch River	1	4	2	3	1	2	2	3	2	3	3	0	0	25	
	2	4	2	2	0	2	2	2	2	2	3	0	0	21	
	3	4	2	3	0	3	2	3	2	3	3	0	0	25	71
Lava Lake	1	3	2	3	2	5	2	2	2	3	3	3	0	30	
	2	4	3	4	4	5	5	4	1	4	5	3	0	42	
	3	5	3	3	1	3	5	4	1	3	3	0	0	31	
	4	4	2	4	2	3	3	5	3	4	4	3	0	37	
	5	3	2	3	2	4	3	5	2	3	4	4	0	35	175
Cedar River	1	4	2	2	1	2	4	1	3	3	2	0	0	24	
	2	4	3	3	0	2	4	1	3	3	5	0	0	28	
	3	3	2	3	1	2	1	2	1	3	3	3	0	24	76
Cutoff Mountain	1	5	2	2	0	5	4	2	4	4	4	0	0	32	
	2	5	2	3	1	4	3	3	3	4	3	-1	0	30	
	3	3	2	3	0	3	3	3	3	4	3	0	0	27	
	4	3	2	3	1	3	3	3	3	3	4	3	0	31	120
Bulkley River	1	3	2	3	1	3	3	4	3	3	5	1	0	31	
	2	3	2	4	3	2	3	5	3	3	4	2	0	34	
	3	2	2	5	4	3	3	5	3	4	4	4	0	39	
	4	5	2	3	1	4	4	2	3	4	3	3	0	34	
	5	4	2	4	2	3	4	2	4	4	4	4	0	37	
	6	4	2	3	1	2	4	2	3	2	5	4	0	32	
	7	2	2	3	4	2	4	3	2	2	4	5	0	33	240
McKendrick Creek	1	3	2	5	0	2	2	1	3	3	4	-1	0	24	
	2	2	2	5	0	3	2	1	2	3	3	-1	0	22	
	3	3	2	4	0	2	2	3	2	2	5	-1	0	24	
	4	3	3	3	1	2	3	2	3	2	3	3	0	28	98
Telkwa	1	1	2	3	5	3	2	3	2	2	4	5	0	32	32
Kitwanga Lake	1	3	2	3	1	3	3	2	3	3	4	-1	0	26	
	2	4	2	4	3	3	3	2	2	3	4	0	0	30	
	3	4	2	4	2	4	3	3	3	3	4	3	0	35	
	4	3	2	5	3	4	3	2	4	3	5	2	0	36	
	5	3	2	4	1	2	3	1	4	2	4	-1	0	25	
	6	4	3	3	2	3	3	3	3	2	4	-1	0	29	
	7	3	2	3	1	3	2	1	3	2	4	3	0	27	
	8	3	2	3	2	3	2	2	3	2	5	3	0	30	238
Seven Sisters Peaks	1	3	2	4	3	5	3	3	3	4	4	2	0	36	
	2	3	2	4	2	5	3	2	3	3	4	3	0	34	
	3	3	2	3	2	4	4	3	2	4	3	3	0	33	
	4	4	2	3	2	5	5	3	2	4	4	3	0	37	140

TABLE V-2 (page 3)

Segment	Subsegment	Impact Ratings												Impact Rating Totals	
		1	2	3	4	5	6	7	8	9	10	11	12	Subsegment	Segment
Zymoetz Creek	1	3	2	3	0	2	3	1	3	3	3	0	0	23	
	2	4	3	3	0	2	4	1	4	3	4	-1	0	26	49
Limonite Creek	1	4	2	3	1	2	4	2	2	3	4	0	0	27	
	2	5	3	2	1	2	2	1	3	4	2	2	0	27	54
Burnie River	1	4	4	3	1	2	4	1	2	3	3	0	0	27	
	2	3	3	2	0	2	3	1	3	2	2	0	0	21	
	3	4	3	2	0	2	2	1	3	3	3	0	1	24	72
Trapline Creek	1	4	2	2	2	2	3	2	2	3	4	0	0	26	26
Thornhill Mountain	1	4	1	2	2	2	3	2	1	3	3	0	0	23	23
Williams Creek	1	4	3	2	0	2	3	1	2	4	4	0	0	25	25
Mount Herman	1	2	1	3	4	3	3	2	1	3	3	4	0	29	29
Skeena River	1	5	4	3	1	2	5	5	5	2	1	0	0	31	
	2	5	3	3	1	3	5	5	4	2	1	0	0	32	
	3	5	3	3	0	2	3	4	4	3	2	0	0	29	
	4	3	3	3	2	3	3	3	4	3	2	0	0	24	
	5	3	2	3	1	2	3	2	4	2	2	0	0	24	
	6	3	2	3	1	2	3	2	3	2	3	0	0	24	
	7	3	2	3	0	2	3	2	3	2	3	0	0	23	192
Nass River	1	5	3	4	0	2	5	4	4	2	2	0	0	31	
	2	3	3	3	0	2	3	3	4	2	3	0	0	26	
	3	3	3	4	0	2	3	2	4	2	4	0	0	27	84
Yaza Creek	1	3	2	3	0	3	3	2	4	2	4	0	0	26	26
Damdochax Creek	1	3	2	3	0	3	4	2	4	2	4	0	0	27	
	2	3	3	3	0	4	4	2	4	2	4	0	0	29	56
Slamgeesh Range	1	4	2	3	0	3	3	3	4	2	5	0	0	29	
	2	3	2	3	0	3	3	2	4	3	4	0	0	28	57
Sicintine River	1	5	2	3	0	2	2	1	3	3	4	0	0	25	
	2	5	3	2	0	2	4	2	3	2	2	0	0	25	
	3	3	3	3	0	2	3	3	3	3	3	0	0	26	76
Shedin Creek	1	5	3	3	0	2	3	1	4	3	2	0	0	26	
	2	5	2	3	0	2	1	1	3	3	3	0	0	23	
	3	4	2	3	0	3	1	2	4	4	4	0	0	27	
	4	4	2	3	0	2	1	2	4	4	4	0	0	26	102
Driftwood Grp - Bear Lake	1	3	2	3	1	4	3	2	4	3	4	0	0	29	
	2	4	2	3	2	5	5	2	4	3	3	0	0	33	
	3	4	2	3	0	3	5	3	3	2	4	0	0	29	91
Squingula River	1	4	2	3	0	2	3	1	4	2	3	0	0	24	
	2	4	2	3	0	2	3	1	4	2	2	0	0	23	47
Onerka Lake	1	4	3	2	0	2	4	2	2	2	2	0	0	23	23
Driftwood River	1	4	3	3	0	2	3	3	3	1	4	0	0	25	25
Driftwood Range	1	3	2	3	0	2	2	3	2	3	5	0	0	26	26
Condit Creek	1	3	3	2	0	2	3	1	2	1	3	0	0	20	20
Kastberg Creek	1	3	2	2	1	3	1	2	2	2	5	-1	0	22	22
Kotsine River	1	3	2	3	0	2	2	3	3	2	3	0	0	23	23
Nilkitkwa Peak	1	3	4	2	0	2	1	4	2	2	2	0	0	22	22

TABLE V-2 (page 4)

		Impact Ratings												Impact Rating Totals	
Segment	**Subsegment**	1	2	3	4	5	6	7	8	9	10	11	12	**Subsegment**	**Segment**
Shelagyote River	1	3	3	3	0	3	1	2	4	2	3	-1	0	23	
	2	4	2	4	0	3	1	2	3	2	3	-1	0	23	46
Nakinilerak Lake	1	3	2	5	0	3	2	2	3	2	3	-1	0	24	
	2	3	2	4	0	3	4	3	4	2	3	0	0	28	52
Omineca Mountains	1	3	2	2	2	3	1	3	3	2	5	-1	0	25	25
Frypan Creek	1	3	2	4	0	2	1	1	4	2	4	0	0	23	
	2	3	2	4	0	3	1	2	4	2	4	-1	0	24	47
Takla - Tezzeron	1	3	2	5	2	5	2	4	1	2	4	-1	0	29	
	2	3	2	5	2	4	3	3	1	2	4	0	0	28	
	3	4	2	5	0	4	3	5	2	2	3	0	0	30	
	4	4	2	4	3	4	3	5	1	3	4	0	0	33	
	5	3	2	3	1	4	5	4	1	2	5	-1	0	29	
	6	3	2	3	1	4	3	4	2	2	5	-1	0	28	
	7	3	2	2	0	3	3	2	2	2	5	-1	0	23	
	8	3	2	1	0	4	3	4	2	2	4	-1	0	24	
	9	4	2	1	2	4	3	2	2	3	5	-1	0	27	251
Great Beaver Lake	1	3	2	1	1	3	1	2	1	2	4	1	0	21	
	2	1	2	1	1	3	1	1	1	2	3	0	0	16	
	3	1	2	1	0	3	1	3	1	2	5	0	0	19	56
Chinohchey Creek	1	4	2	1	2	3	2	3	3	2	5	2	0	29	29
Cluculz Lake	1	2	2	2	4	4	2	4	2	2	5	2	0	31	31
Babine Lake	1	3	2	4	0	5	2	5	4	3	5	-1	0	32	
	2	3	2	3	0	4	2	3	3	3	4	-1	0	26	
	3	4	2	1	1	3	2	3	4	3	4	1	0	28	
	4	4	2	1	1	4	3	3	4	2	4	-1	0	27	113
Cunningham Lake	1	4	2	1	1	5	3	4	2	3	4	1	0	30	30
Stuart Lake	1	2	2	2	0	3	3	3	2	2	5	-1	0	21	
	2	2	2	1	1	3	1	2	2	2	4	-1	0	19	
	3	1	3	1	2	3	1	1	2	2	4	1	0	21	61
Sutherland River	1	5	2	1	1	2	3	2	2	3	4	-1	0	24	
	2	4	2	1	0	2	3	2	2	2	3	0	0	21	
	3	3	2	1	0	3	1	1	2	1	4	-1	0	17	62
Burnstead Creek	1	2	2	1	1	3	1	1	1	2	4	-1	0	17	
	2	2	2	1	2	3	1	2	3	2	4	2	0	24	41

APPENDIX V

STIKINE-ISKUT TRANSMISSION STUDIES

ESTIMATED TOTAL COST FOR ENVIRONMENTAL ALTERNATIVES

System Option	Environmental Alternative	Corridor Length (km)*[1]	Circuit Length (km)*[2]	Direct Transmission Cost ($ Million)*[3]	Direct Station Cost ($ Million)*[3]	Total Alternative Cost ($ Million)*[4]
I	A	662	1551	628	103	3180
	B	697	1614	656	92	3256
	C	802	1720	703	92	3614
	D	770	1751	732	92	3748
II	E	707	1726	697	110	3509
	F	811	1799	811	110	4189
III	G	1102	1986	852	158	4592
IV	H	984	2391	1000	192	5417

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*[1] From environmental report.

*[2] Includes the 230 kV single circuit line that would be required from More Creek.

*[3] The direct cost estimates are in 1981 dollars.

*[4] The total cost estimate includes inflation, corporate overhead and interest during construction based on in-service dates for More Creek and Iskut Canyon of 1993 and for Stikine Canyon and Tanzilla of 1995 and 1997 respectively.

APPENDIX VI

TECHNICAL EVALUATION

STIKINE/ISKUT TRANSMISSION
TECHNICAL EVALUATION TABLE

		RATINGS LOW				HIGH
		I	II	III	IV	V
EVALUATION COMPONENTS	DESIGN CONSIDERATIONS					
	-Topography	no sidehill	rolling, some sidehill	30' average sidehill	over 30' aerage sidehill	extreme sidehill
	-Conductor Loading	light loading	light loading	mediun loading	high loading	extreme loadings
	-Deflections	low percent of deft	medium percent of deft	med-high percent of deft	high percentage of deft	Individual site selection
	ACCESS	Good existing access from other linear develapements	Access to R/W at frequent points not far from existing roads New roads construction easy	some access; new road construction possible	no existing access; new road construction difficult	Inaccessible to vehicles
	CLEARING	Little clearing; range land with scattered individual trees	easy machine clearing	moderate machine clearomg; some hand clearing	Extensive hand clearing; forests that will not be difficult	Totally hand cleared; sites, densely forested slopes
	SPECIAL CONSIDERATIONS	none	minimal	moderate	high	extreme

TABLE VI-1

[12,13KLYTAB

SEGMENT	LENGTH (km)	EVALUATION COMPONENTS			
		DESIGN CONSIDERATIONS	ACCESS	CLEARING	SPECIAL CONSIDERATIONS
1-2	25	II	III	II	II
2-3	31	I	I	II	II
2-4	87	II	III	II	II
2-34	55	II	III	II	II
3-4	60	II	I	II	II
3-34	19	II	III	III	I
4-5	46	II	II	II	II
5-6*	11*	I	I	II	II
5-7	20	II	II	III	I
5-14	35	IV	I	IV	V
6-8*	29*	II	III	III	I
7-8	4	IV	V	V	V
8-9	14	IV	V	V	II
9-10	20	III	V	V	II
10-11	38	III	IV	III	III
11-12	13	IV	IV	IV	IV
12-13	21	III	III	III	I
13-14	42	III	I	III	II
13-15	48	II	II	III	II

*230 kV T/L ONLY

NOTES:

1. FOR EXPLANATION OF EVALUATION SYSTEM REFER TO TABLE VI -1 (TECHNICAL EVALUATION TABLE)

SEGMENT	LENGTH (km)	EVALUATION COMPONENTS			
		DESIGN CONSIDERATIONS	ACCESS	CLEARING	SPECIAL CONSIDERATIONS
13-36	56	III	III	III	III
15-16	100	II	III	II	II
15-19	75	II	III	II	II
15-21	48	I	III	II	II
16-17	52	III	I	III	I
16-19	32	II	II	II	I
17-18	50	II	I	II	I
17-20	36	III	II	II	III
18-25	10	I	II	II	II
19-20	45	III	IV	III	III
21-22	69	II	I	II	II
21-30	34	II	I	II	II
21-57	21	I	III	II	II
22-23	62	II	II	III	I
22-26	51	II	I	II	II
23-24	38	III	II	III	I
24-25	10	IV	IV	III	I
24-27	33	III	II	III	II
25-28	24	II	III	III	II
26-27	60	II	III	II	II

STIKINE/ISKUT TRANSMISSION
TECHNICAL RATINGS
TABLE VI -2
(PAGE 1 OF 2)

SEGMENT	LENGTH (km)	EVALUATION COMPONENTS			
		DESIGN CONSIDERATIONS	ACCESS	CLEARING	SPECIAL CONSIDERATIONS
26-29	48	I	I	II	I
27-28	20	II	III	III	II
27-59	21	III	III	IV	II
28-33	37	IV	IV	IV	IV
29-31	7	I	I	II	I
29-59	40	II	II	II	II
30-41	28	II	I	II	II
30-57	48	II	I	II	I
31-32	19	I	I	II	I
31-33	61	II	III	II	I
32-41	140	II	II	II	I
32-43	119	II	II	II	I
34-35	83	II	III	II	II
35-36	72	II	III	III	II
35-44	81	II	II	II	II
36-37	20	II	III	III	II
36-38	47	II	III	II	II
37-38	41	II	III	II	II
37-39	44	II	III	III	II
38-57	39	I	III	II	II
39-40	34	III	III	III	II
39-42	80	III	IV	II	II
39-45	33	II	III	III	II
40-41	57	II	III	II	II
40-56	44	II	III	II	II
41-56	20	I	II	II	I
42-43	31	I	III	II	I
43-46	22	I	III	II	I
43-47	25	I	II	II	I
44-58	68	II	I	II	I
45-46	70	II	III	II	II
45-58	16	II	I	II	I
45-60	13	III	II	II	II
46-47	46	I	I	II	I
47-53	114	II	I	II	I
48-49	80	II	II	II	II
48-54	96	I	II	II	I
48-60	47	III	II	II	II
49-50	85	III	III	III	II
50-51	160	II	III	II	II
51-52	6	I	I	II	I
51-55	88	II	II	II	I
53-54	84	I	II	II	I
53-55	69	II	III	II	II
58-60	24	III	II	II	II

*230 kV T/L ONLY

NOTES:

1. FOR EXPLANATION OF EVALUATION SYSTEM REFER TO TABLE VI -1(TECHNICAL EVALUATION TABLE)

STIKINE/ISKUT TRANSMISSION

TECHNICAL RATINGS

TABLE VI -2

(PAGE 2 OF 2)

		I ZERO -- VERY LOW	II LOW	III MODERATE	IV HIGH	V EXTREME
AVALANCHE		LITTLE SNOW ACCUMULATION. SLOPES < 10°-30°. TREE COVERED REMOTE POSSIBILITY OF OCCURANCE	SNOW ACCUMULATION < 1.5 m SLOPE ANGLES < 30° OR > 50° NO EXISTING AVALANCHE PATHS. POSSIBILITY OF OCCURANCE ON OPEN SLOPE DURING UNUSUALLY HEAVY SNOW FALL	STARTING ZONE: - SNOW DEPTH > 1.5 m - SLOPE ANGLE 30°-50° - TREE COVERED A FEW CONFINED AVALANCHE PATHS. POSSIBILITY OF SPANNING OR PASSING NEAR ENDS OF RUNOUT ZONES	STARTING ZONE: -SNOW DEPTH > 1.5 m -SLOPE ANGLE 30°-50° -BARE OF TREES NUMEROUS, CONFINED AVALANCHE PATHS AT LEAST ONE LARGE AVALANCHE/PATH/YR AVOIDANCE OF MOST PATHS DIFFICULT	STARTING ZONE: -SNOW DEPTH > 1.5 m -SLOPE ANGLE 30°-50° -BARE OF TREES NUMEROUS, INTERFINGERING OR UNCONFINED AVALANCHE PATHS. MORE THAN ONE LARGE AVALANCHE/PATH/YR. NO POSSIBILITY OF SPANNING OR AVOIDING PATHS.
SLOPE FAILURE	LANDSLIDE	FLAT TO MODERATE TERRAIN WELL DRAINED, GENERALLY HOMOGENIOUS MATERIAL OR BEDROCK	FLAT TO MODERATE TERRAIN, FLOOD PLAIN, FAN OR DELTA. GENERALLY WELL DRAINED BUT MATERIAL NOT HOMOGENIOUS CAUSING LOCALIZED AREAS OF POOR DRAINAGE.	HILLY, GLACIATED TERRAIN. NUMEROUS SWAMPS LAKES, MEANDERING STREAMS. INTERBEDDED MATERIALS. DRAINAGE GENERALLY POOR. EXISTING FAILURES SMALL.	HILLY, GLACIATED TERRAIN, OLD LANDSLIDE DEPOSITS, INTERBEDDED MATERIALS OF HIGHLY VARYING PERMEABILITY, POOR DRAINAGE. SLOPES UNDERCUT BY EROSION. SOME LARGE EXISTING FAILURES.	AREA OF EXTENSIVE, RECENT LANDSLIDE ACTIVITY CHARACTERIZED BY TENSION CRACKS, BLOCKED DRAINAGE, SEEPAGE ZONES AND HUMMOCKY GROUND. MATERIAL CONTAINS FINE GRAINED SILT AND CLAY OR OVERLIES SHALE. AREA CANNOT BE AVOIDED.
	DEBRIS (MUD) FLOW	TERRAIN FLAT TO GENTLY ROLLING THICK SOIL MANTLE OVERLYING BEDROCK. MATERIAL WELL DRAINED. LIGHT RAINFALL OR SNOWMELT.	FLAT TO MODERATE TERRAIN WITH SLOPES < 25°. THIN MANTLE OF SOIL OVERLYING BEDROCK. LIGHT RAINFALL AND SNOWMELT.	STEEP TERRAIN WITH SLOPES > 25° THIN MANTLE OF SOIL OVERLYING BEDROCK. POOR-MODERATE DRAINAGE. TREECOVER NOT REMOVED. PERIODS OF HEAVY RAINFALL. NO PREVIOUS SLIDES VISIBLE.	STEEP TERRAIN WITH SLOPES > 25° THIN MANTLE OF SOIL OVERLYING BEDROCK, POOR DRAINAGE. AREA SUBJECT TO HIGH INTENSITY RAINFALL. TREECOVER REMOVED BUT GROUNDCOVER RE-ESTABLISHED. SOME PREVIOUS SLIDES VISIBLE.	STEEP TERRAIN WITH SLOPES > 25° THIN MANTLE OF SOIL OVERLYING BEDROCK. POOR DRAINAGE. AREA SUBJECT TO HIGH INTENSITY RAINFALL AND SNOWMELT). TREECOVER RECENTLY REMOVED OR SOIL MANTLE DISTURBED. NUMEROUS PREVIOUS SLIDES VISIBLE.
	ROCKFALL	FLAT TO GENTLY ROLLING TERRAIN. UNCONSOLIDATED MATERIAL OR GENTLY ROLLING BEDROCK AREAS.	GENTLY ROLLING TERRAIN WITH MODERATE SLOPES CONSISTING OF MASSIVE DISCONTINUOUSLY JOINTED ROCK NOT SUSCEPTABLE TO EROSION.	STEEP ROCK SLOPES > 20°. FAVOURABLE ORIENTATION OF JOINTS AND BEDDING. FEW FAULT ZONES, EXISTING ROCKFALLS CONFINED TO CHUTES AND GULLIES. SLOPE NOT UNDERCUT BY EROSION. GOOD POSSIBILITY OF AVOIDING EXISTING ROCKFALLS.	STEEP ROCK SLOPES > 20°. DOWNSLOPE ORIENTATION OF JOINTS OR BEDDING. NUMEROUS FAULT ZONES AND EXISTING ROCKFALLS. SLOPES NOT UNDERCUT BY BY EROSION ETC. SOME POSSIBILITY OF AVOIDING EXISTING ROCKFALLS.	STEEP ROCK SLOPES > 20°. DOWNSLOPE ORIENTATION OF JOINTS OR BEDDING. NUMEROUS FAULT ZONES AND EXISTING ROCKFALLS. SLOPE UNDERCUT BY RIVER EROSION OR CONSTRUCTION ACTIVITY GREAT DIFFICULTY OF AVOIDING EXISTING ROCKFALLS.
FLOOD AND RIVER EROSION		FLAT TO GENTLY ROLLING TERRAIN. A FEW WELL CONFINED STREAMS WITH REMOTE POSSIBILITY OF FLOODING OR COURSE CHANGE.	MODERATE TO STEEP TERRAIN. FEW INTERSECTING STREAMS WITH SOME POSSIBILITY OF FLOODING OR COURSE CHANGE.	OBLIQUE CROSSING OF WIDE FLOODPLAIN OF MAJOR CREEK OR RIVER PRONE TO FLOODING. A FEW STRUCTURES REQUIRED ON FLOODPLAIN OR SOME INTERSECTING STREAMS PRONE TO FLOODING OR COURSE CHANGE. SOME POSSIBILITY OF AVOIDANCE.	LINE LOCATED ON FLOODPLAIN. MOUNTAINOUS TERRAIN PRONE TO HIGH INTENSITY RAINFALL AND SNOWMELT. RIVER CHANNEL GENERALLY CONFINED BUT PRONE TO COURSE CHANGE. LINE CROSSES MOUTHS OF NUMEROUS STREAMS SUBJECT TO FLOODING OR COURSE CHANGE	LOCATED ON FLOODPLAIN. MOUNTAINOUS TERRAIN PRONE TO HIGH INTENSITY RAINFALL AND SNOWMELT. RIVER CHANNEL UNCONFINED AND PRONE TO PERIODIC COURSE CHANGE. FLOOD-PLAIN STREWN WITH DEBRIS.
ICE AND WIND LOADING		COMPLETELY SHELTERED. AIR MASSES GENERALLY DRY. TEMPERATURES RARELY BELOW FREEZING.	GENERALLY SHELTERED AND AT LOWER ELEVATIONS. SOME EXPOSURE TO MOIST AIR. PERIODIC TEMPERATURES BELOW FREEZING.	GENERALLY EXPOSED TO PREVAILING WINDS AND/OR MOIST AIR MASSES. SUSTAINED TEMPERATURES BELOW FREEZING.	MOSTLY EXPOSED TO PREVAILING WIND AND MOIST AIR MASSES. SUSTAINED TEMPERATURES BELOW FREEZING. LINE OBLIQUE OR PARALLEL TO PREVAILING WIND & GENERALLY ABOVE TREELINE OR AREA PRONE TO ENTRAPMENT OF COLD ARCTIC AIR BY MOIST COASTAL AIR.	COMPLETE TRANSVERSE EXPOSURE TO HIGH VELOCITY, PREVAILING WINDS. MOIST AIR MASSES AND SUSTAINED TEMPERATURES BELOW FREEZING.

STIKINE/ISKUT TRANSMISSION
SECURITY EVALUATION
TABLE VI -3

SEGMENT	HAZARD					
	AVALANCHE	SLOPE FAILURE			FLOODS (RIVER) EROSION	WIND & ICE LOADING
		LAND-SLIDE	DEBRIS-MUD FLOW	ROCK FALL		
1-2	I	I	I	I	I	II
2-3	I	I	I	I	I	II
2-4	II	II	II	I	II	II
2-34	I	II	II	I	I	II
3-4	II	I	II	II	II	III
3-34	I	II	II	I	III	II
4-5	II	II	II	I	II	III
5-6*	I	III	I	I	III	III
5-7	III	II	III	III	I	III
5-14	IV	III	I	I	II	III
6-8*	III	II	III	III	I	III
7-8	II	II	III	III	I	III
8-9	III	II	III	III	I	III
9-10	IV	II	III	III	III	II
10-11	II	I	I	I	I	IV
11-12	IV	III	III	II	II	IV
12-13	II	II	I	I	II	II
13-14	II	II	II	I	II	III
13-15	II	II	II	I	II	III

*230 kV T/L ONLY

NOTES:

1. FOR EXPLANATION OF EVALUATION SYSTEM REFER TOTABLE VI -3(SECURITY EVALUATION TABLE)

SEGMENT	HAZARD					
	AVALANCHE	SLOPE FAILURE			FLOODS (RIVER) EROSION	WIND & ICE LOADING
		EARTH-FLOW	DEBRIS-MUD SLIDE	ROCK-FALL		
13-36	III	III	III	II	II	IV
15-16	I	II	II	I	II	II
15-19	I	I	II	II	II	II
15-21	I	II	I	I	II	II
16-17	I	II	II	II	II	II
16-19	I	I	II	II	II	II
17-18	I	II	II	I	III	II
17-20	III	III	II	II	I	II
18-25	I	I	I	I	I	I
19-20	III	III	III	II	II	III
21-22	I	II	I	I	II	II
21-30	I	I	I	I	I	II
21-57	I	III	II	II	II	II
22-23	I	IV	IV	III	II	II
22-26	I	II	I	I	II	II
23-24	I	IV	IV	III	IV	II
24-25	I	I	IV	IV	IV	II
24-27	II	III	III	III	IV	II
25-28	III	III	III	II	II	II
26-27	I	II	I	I	I	II

STIKINE/ISKUT TRANSMISSION

SECURITY RATINGS

TABLE VI -4

(PAGE 1 OF 2)

SEGMENT	HAZARD					
	AVALANCHE	SLOPE FAILURE			FLOODS (RIVER) EROSION	WIND & ICE LOADING
		LAND-SLIDE	DEBRIS-MUD FLOW	ROCK-FALL		
26-29	I	II	I	I	II	II
27-28	III	I	II	II	II	II
27-59	III	III	III	III	III	II
28-33	III	I	II	II	II	IV
29-31	I	I	I	I	I	I
29-59	I	III	III	II	II	II
30-41	I	I	I	I	I	II
30-57	I	I	I	I	I	II
31-32	I	I	I	I	I	II
31-33	I	I	I	I	I	I
32-41	I	I	I	I	I	II
32-43	I	II	I*	I	I	II
34-35	II	II	II	I	III	II
35-36	I	II	II	I	III	II
35-44	III	III	III	II	II	III
36-37	I	II	II	I	II	II
36-38	I	II	II	II	II	II
37-38	II	II	II	I	I	II
37-39	II	II	II	I	II	II
38-57	I	III	II	II	II	II
39-40	I	II	II	I	II	II
39-42	I	III	III	II	II	II

*230 kV T/L ONLY

NOTES:

1. FOR EXPLANATION OF EVALUATION SYSTEM REFER TO TABLE VI -3(SECURITY EVALUATION TABLE)

SEGMENT	HAZARD					
	AVALANCHE	SLOPE FAILURE			FLOODS (RIVER) EROSION	WIND & ICE LOADING
		EARTH-FLOW	DEBRIS-MUD FLOW	ROCK-FALL		
39-45	I	II	II	I	II	II
40-41	I	II	II	I	II	II
40-56	I	II	II	I	II	II
41-56	I	I	I	I	I	II
42-43	I	II	II	II	II	II
43-46	I	I	I	I	I	II
43-47	I	I	I	I	I	II
44-58	I	II	II	I	II	II
45-46	I	II	II	I	I	II
45-58	I	II	II	I	II	II
45-60	I	II	II	II	I	II
46-47	I	I	I	I	I	II
47-53	I	II	I	I	II	II
48-49	I	II	II	II	I	II
48-54	I	II	I	I	I	II
48-60	I	II	II	II	I	II
49-50	I	II	II	II	I	II
50-51	I	II	II	II	I	II
51-52	I	I	I	I	II	II
51-55	I	II	I	I	I	II
53-54	I	II	I	I	I	II
53-55	I	II	I	I	II	II
58-60	I	II	II	II	I	II

STIKINE/ISKUT TRANSMISSION

SECURITY RATINGS

TABLE VI -4

(PAGE 2 OF 2)

SEGMENT	LENGTH (km)	NUMBER OF LINES	COST $ x 1000
31-32	19	1	5920
		2	11757
		3	17595
		4	23431
32-41	140	2	100675
		3	149387
32-43	119	2	87063
		3	128670
34-35	83	2	69022
		3	98626
35-36	72	2	61312
		3	89578
35-44-58	149	2	118061
		3	173253
36-37	20	2	17509
		3	25549
36-38	47	2	42509
		3	61268
36-37-38	61	2	52043
		3	76001
37-38	41	2	34534

SEGMENT	LENGTH (km)	NUMBER OF LINES	COST $ x 1000
37-38	41	3	50452
37-39	44	2	38486
		3	56174
38-57	39	2	31429
		3	45298
39-40	34	2	34706
		3	50760
39-42-43	111	2	103871
		3	150575
39-45	33	2	28917
		3	42182
40-41	57	2	45298
		3	66997
40-56-41	64	2	48706
		3	71768
43-46	22	2	15828
		3	23248
43-47	25	2	18126
		3	26557
45-46	70	2	56373
		3	81993

SEGMENT	LENGTH (km)	NUMBER OF LINES	COST $ x 1000
45-58	16	2	12413
		3	18348
45-60	13	2	12586
		3	17943
46-47	46	2	32665
		3	48097
47-53	114	2	81224
		3	119557
48-49-50-51	325	2	257393
		3	381306
48-54-53	180	2	125018
		3	183568
48-60	47	2	43445
		3	64874
51-52	6	2	3704
		3	5505
51-55-53	157	2	112751
		3	165786
58-60	24	2	22184
		3	33126

NOTES:

1. COST ESTIMATES ARE BASED ON CONSTRUCTION OF 500 kV SINGLE CIRCUIT TRANSMISSION LINES IN OTHER PARTS OF B.C.
2. DOUBLE CIRCUIT 500 kV COST ESTIMATE SHOWN FOR SEGMENT 5-14-13.
3. INFLATION, CORPORATE OVERHEAD AND INTEREST DURING CONSTRUCTION ARE NOT INCLUDED IN THESE COST ESTIMATES.

STIKINE/ISKUT TRANSMISSION DIRECT COST ESTIMATES

TABLE VI-5

SEGMENT	LENGTH (km)	NUMBER OF LINES	COST $ x 1000
1-2	25	2	20069
2-3	31	2	19505
		3	28393
		5	46041
2-4	87	2	75968
2-3-4	91	2	67013
2-34	55	2	46316
		3	68068
2-3-34	50	2	35262
3-4	60	1	24720
		2	47508
3-34	19	2	15757
		3	23030
4-5	46	1	17654
		2	32813
5-6*	11	1*	1526
5-7-8-9	38	1	24053
		2	46615
5-14-13	77	1	44348
		2	86726
		DOUBLE CIR.	92906
		DOUBLE + 1	135284
6-8-9*	43	1*	9976

SEGMENT	LENGTH (km)	NUMBER OF LINES	COST $ x 1000
9-10-11-12-13	92	1	62246
		2	115121
13-15	48	1	18817
		3	53237
13-36	56	1	33780
		2	63069
15-16	100	1	45380
15-19	75	1	29770
15-21	48	1	20036
		2	37567
		3	55098
16-17	52	1	23432
16-19	32	1	14420
17-18	50	1	17593
17-20-19	81	1	38896
18-25	10	1	3285
21-22	69	1	21990
		2	42307
		3	62624
21-30	34	1	13777
		2	26345
		3	39242
21-57	21	2	16925

SEGMENT	LENGTH (km)	NUMBER OF LINES	COST $ x 1000
21-57	21	3	24394
22-23-24	100	1	61144
22-26	51	1	21182
		2	40167
		3	59152
24-25	10	1	5890
24-27	33	1	14404
25-28	24	1	9213
26-27	60	1	24996
26-29	48	2	29834
		3	44402
27-28	20	1	7622
27-59-29	61	1	23798
28-33-31	98	1	47204
29-31	7	1	2181
		2	4332
		3	6482
		4	8634
30-41	28	1	11558
		2	21945
		3	32604
30-57	48	2	37580
		3	55851

* 230 kV T/L ONLY

NOTES:

1. COST ESTIMATES ARE BASED ON CONSTRUCTION OF 500 kV SINGLE CIRCUIT TRANSMISSION LINES IN OTHER PARTS OF B.C.
2. DOUBLE CIRCUIT 500 kV COST ESTIMATE SHOWN FOR SEGMENT 5-14-13.
3. INFLATION, CORPORATE OVERHEAD AND INTEREST DURING CONSTRUCTION ARE NOT INCLUDED IN THESE COST ESTIMATES.

STIKINE/ISKUT TRANSMISSION DIRECT COST ESTIMATES

TABLE VI-5

APPENDIX VII

MAJOR PROJECT PROCUREMENT POLICY AND PRELIMINARY PROCUREMENT PLAN

APPENDIX VII

MAJOR PROJECT PROCUREMENT POLICY AND PRELIMINARY PROCUREMENT PLAN

1. B.C. Hydro Procurement Policy

B.C. Hydro invites tenders in accordance with clauses 14 and 15 of the Hydro and Power Authority Act and will give preference to tenders that offer products of British Columbian and Canadian manufacture. The Hydro and Power Authority Act, clauses 14 and 15, states:

> 14. Tenders The Authority shall invite tenders by public advertisement, or when impracticable then by public notice, for the construction and repair of all power plants, except in case of pressing emergency, where delay would be injurious to the public interest or where from the nature of the work it can be more expeditiously and economically executed by the officers and servants of the Authority.
>
> 15. Opening Tenders The Authority shall open all tenders received in each case in public at a time and place stated in the advertisement or notice inviting the tenders, and the prices shall then and there be made known.

2. Preference to British Columbian and Canadian Products

Tenderers are advised that it is B.C. Hydro's policy that where, in the sole discretion of B.C. Hydro, it believes circumstances so warrant, a preference of up to 10 percent will be given to tenders, which offer products of British Columbian manufacture, or where such manufacture is not possible, a preference of up to 5 percent will be given to products of Canadian manufacture. Tenderers are invited to disclose the British Columbian and Canadian content of their tenders in appendices, marked B and C respectively, to their tender document.

3. Preliminary Procurement Plan

A preliminary procurement plan outlines generally the goods and services needed for the project, and estimates the procurement opportunities for suppliers in British Columbia, in Canada and elsewhere. The plan indicates the probable direct economic value of the project to British Columbia's business community.

Goods and Services Required for Typical

500 kV transmission Projects

	Contract	Traditional Source of Supply	Estimated Percentage of Project Costs
1. **Services**			
Engineering Property Acquisition and Survey Misc. Material Handling	B.C. Hydro	B.C.	7.8
2. **Materials**			
Fndn. & Tower Steel	Yes	Can., Jap., Italy	
Fndn. & Tower Bolts	Yes	Can., Jap., Italy	9.7
Guy Strand	Yes	B.C., Can., Jap., Korea	0.3
Guy Hardware, Anchors & Anchor Roads	Yes	Can.	1.2
Conductor	Yes	B.C., Can.	24.5
Insulators	Yes	Jap., Fr.	2.0
Suspension & D.E. Hardware	Yes	Can., Fr., Jap.	1.6
Spacer Dampers	Yes	Can.	1.3
Compression Fittings	Yes	Can.	0.3
			40.9
3. **Labour**			
Construction	Yes	B.C.	45.3
Clearing	Yes	B.C.	6.0
		TOTAL	100.0

The above table sets out generally the procurement requirements for a typical 500 kV transmission project. Engineering services are provided within B.C. Hydro. All other contracts for goods and services are awarded through an open, world-wide bidding process.

Past experience shows that most project dollars are spent within British Columbia. However, some specialized materials are purchased internationally from suppliers in France, Italy, Japan, Korea and the United States.

Almost all construction and clearing is done by local B.C. labour. Occassionally, specialized construction equipment and personnel are imported from elsewhere in North America.

The above table applies generally to the procurement requirements of the Stikine-Iskut transmission project. Direct costs are estimated to be about 750 million dollars in 1981 dollars. Actual costs will depend upon prevailing economic conditions and upon the final project design. However, the basic requirements for goods and services will not change nor will the proportions of project costs shown vary significantly.

APPENDIX VIII

PRELIMINARY LIST OF APPROVALS, LICENCES AND PERMITS

APPENDIX VIII

PRELIMINARY LIST OF APPROVALS, LICENCES AND PERMITS

Prior to construction, the following approvals, licences or permits, where applicable, may be required for this transmission project:

1. Crown releases (e.g., mineral claims, grazing leases, park reserves, etc.);
2. Letter of commitment from the Ministry of Lands, Parks and Housing;
3. Licence to cut pursuant to the Forest Act prior to logging and clearing;
4. Special Case Order (B.C. Reg. 313/78, S.44) from the Agricultural Land Commission for crossing over lands designated agricultural land reserve;
5. Permits under the Navigable Waters Protection Act for crossing over navigable waterways;
6. Various approvals and permits for crossings over pipelines and railway tracks; and
7. Other permits and approvals may be required under the Waste Management Act, Municipal Act, and municipal and regional regulations for work associated with transmission line construction carried out by contractors.

APPENDIX IX

GLOSSARY OF TERMS USED IN THIS REPORT

APPENDIX IX

GLOSSARY OF TERMS USED IN THIS REPORT

Alignment	- The centre line for the transmission line right-of-way prior to survey.
Capacitor Station	- An electrical station placed on a transmission line to improve voltage levels and to increase power transfer capability.
Capacity	- Rated output power of a machine, apparatus or station, measured in watts, kilowatts, horsepower, etc.
Centre line survey	- The procedure of establishing the precise location of the proposed transmission line on the ground and of determining its topographic profile for design purposes.
Circuit	- A system of conductors through which an electric current passes. In most instances one circuit is placed on a single set of transmission towers.
Collector Station	- An electrical station used to combine power from two or more generation sources by means of interconnecting transmission lines.
Conductor	- A cable or wire made usually of aluminum or of aluminum and steel, which is used to carry electricity.
Corridor	- A general term for a strip of land of indeterminate width within which the proposed transmission lines could be located.
Distribution	- Low voltage electric transmission network generally at voltages below 60 kV, for distributing electricity to customer premises.
Double Circuit Construction	- The type of design used to place two separate transmission circuits on a single set of transmission towers.

Electric Current	- The flow of electricity in a conductor, measured in amperes.
Electric Power	- The instantaneous rate at which electric energy is generated or consumed usually expressed in watts or kilowatts. Often used in the broader sense as a synonym for electricity.
Electricity	- A form of energy generated by induction, friction, or chemical change which separates the electric charges that constitute the basic atomic particles of all matter. Also used in the broader sense as a synonym for power and electric power.
Grid	- See 'System Grid'.
Integrated System	- The interconnected network of transmission lines and substations linking generating stations to one another and to customers throughout an electric system.
Hydroelectric Generating Plant	- A plant which generates electricity from the energy of falling water spinning a turbine.
Load	- The amount of electricity required by a customer or group of customers.
Load Forecast	- An estimate of customers' power and energy requirements at some future time.
Mitigation	- Alteration of a project in such a way as to avoid or reduce negative impacts.
Right-of-way	- A legally acquired strip of land in which transmission lines are located.
Route selection studies	- Detailed social and environmental impact studies of the preferred least impact corridor(s) identified during system planning and route engineering studies to determine the least impact

	route for the proposed transmission lines within the corridor(s).
Segment	- A specific length of corridor.
Stringing	- The procedure of placing the conductors on the transmission towers.
Study Area	- The broad area within which the proposed transmission line corridors are located.
Subsegment	- One of a number of subdivisions of any given corridor segment.
Substation	- An electrical station which converts a transmission line at one voltage to a transmission line at another, usually lower, voltage (e.g. 500 kV to 230 kV).
Switching Station	- An electrical station used to divert electricity at a particular voltage from one transmission line onto a different transmission line.
System Grid	- Major transmission lines (500 kV) and their associated switching stations and substations.
System Stability	- The ability of the generators in the system to remain synchronized following electrical disturbances.
Transformation	- The changing of alternating current electricity from one voltage to another.
Transmission	- A system for transporting or conveying electricity in bulk to convenient points where it may be "stepped down" in voltage for delivery to customers via a distribution network.